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EDUCATION FOR THE VETERINARY PROFESSION

ON p. 60 of this issue we refer to some addresses which were given to the National Veterinary Medical Association of Great Britain and Ireland at its sixty-first annual general meeting in London last September. These addresses, and the discussions which followed them, make it clear that the veterinary profession is—and always must be—of fundamental importance to the health of man and to the progress of his civilization. In times like our own, when the basic importance of nutrition is being so often and so rightly emphasized by responsible authorities all over the world, it will scarcely be denied that without successful agriculture our post-war reconstruction will not succeed ; and it will not be denied that the key to successful agriculture is a fertile soil. An important condition of soil fertility is the maintenance of a healthy livestock to fertilize it. Both the veterinary surgeon and the farmer are, therefore, key men of the future. They must always work in collaboration.

These fundamental conditions of successful agriculture have been recognized in recent years by the Ministry of Agriculture and by the Agricultural Research Council. Some years ago these bodies established a network of interacting links between the farmer and the veterinary surgeon on one hand and, on the other, between the farmer and experts in botany, soil science, genetics, farm economics, nutritional science and other branches of scientific inquiry which directly or indirectly affect the production by the farmer of the national food supply. These experts work either in agricultural institutes established and maintained by the Government, or in similar institutes which are attached, sometimes by the financial link only, to the universities. In these institutes or at other key points in Great Britain a number of advisory officers have been stationed by the Ministry of Agriculture, and it is the duty of these advisory officers to keep in touch with the farmers and to interpret to them the results of scientific research. Veterinary surgeons constitute one group of these advisory officers ; and they, in the course of their work, bring not only the farmer but also the veterinary surgeon into relationship with the work of the universities. There is nothing in this scheme to bring the veterinary surgeon into relationship with the other great profession which deals with national health, namely, the medical profession ; but there is no doubt that the scheme has greatly benefited the farmer and the veterinary surgeon and also the national production of food.

If, however, the farmer needs the veterinary surgeon to maintain his livestock for the purpose of fertilization of his soil and for crop-production, he needs him also to maintain the health and genetical constitution of a livestock which is in itself the raw material of our considerable industry in animals and their products. The value of this industry is estimated by the President of the National Veterinary Medical Association at some £200,000,000 a year. British livestock has, moreover, formed the nucleus

of the best herds and flocks of the Dominions overseas, of the Americas and of many other countries; because of the excellence of this stock, Great Britain has been called the stud farm of the world; and our trade in livestock exported for breeding purposes only has been a valuable one. Our breeding stock is, in the opinion of some experts, still in good condition, in spite of the difficulties of four years of war. Expert opinion, however, agrees with the Minister of Agriculture that this is not true of the general livestock in our fields. If this is so, it is not the fault of the veterinary profession, which works manfully against the difficulties of war to maintain the health of all our domesticated animals. The profession is not a large one. The President of the National Veterinary Medical Association (*Vet. Rec.*, **55**, 395; 1943) states that there are less than 3,000 active veterinary surgeons in Great Britain to-day, about one third of whom man the State Veterinary Service or hold other public, educational or similar whole-time appointments, the remainder being in private practice. They have by their constant vigilance so reduced the risk of the major rapidly spreading epidemics of disease in farm animals that it is negligible in Great Britain and in those of our Colonies where veterinary surgeons have been able to tackle diseases of this kind on their own responsibility. Losses from disease are nevertheless considerable in all countries. The President of the National Veterinary Medical Association estimates that they cost Great Britain £30,000,000 a year. To lessen this loss the veterinary profession is doing all that it can with the resources and facilities placed at its disposal. It has performed, and daily performs, many dull and exacting and unspectacular routine tasks of health supervision, meat inspection and the like. It is clear that its education and its general status is a matter of public importance. A brief review of its organization will help in understanding its position in relation to national affairs and the general trend of changes in this position which have either occurred recently or have been proposed for the future.

When John Hunter sponsored the foundation of the Royal Veterinary College of London, he began a process of education in animal health which will, if we read the signs of the times correctly, proceed to the position which responsible authorities desire, namely, the incorporation of veterinary education in a general scheme for the control of both animal and human health. Four other veterinary colleges now help the London College to undertake the education of veterinary surgeons. These are the Royal (Dick) Veterinary College of Edinburgh, the Glasgow Veterinary College (Incorporated), the Veterinary College of Ireland, Dublin, and the School of Veterinary Science of the University of Liverpool. The creation of two other colleges at Bristol and Cambridge has been recently suggested. All the existing colleges are authorized by Royal Sign Manual to train veterinary students for examinations which are held by one examining body and one only—the Royal College of Veterinary Surgeons. This is a corporate body established by Royal Charter in 1844 and composed of those who have been students of the affiliated colleges mentioned above and who have been admitted to membership of the Royal College by passing the examinations controlled by that College. The Royal College of Veterinary Surgeons is thus to be clearly distinguished from the Royal Veterinary College of London, which is purely a teaching college, and from the National Veterinary Medical Association, which is an association of qualified veterinary surgeons, and is akin to the British Medical Association. The functions of the Royal College of Veterinary Surgeons are analogous to those of the General Medical Council, except that the Council of the Royal College of Veterinary Surgeons has sole control of the only examinations which qualify a veterinary student to practise as a veterinary surgeon and of the examiners who conduct these examinations. Its further duties are to keep a register of veterinary surgeons and to discharge certain functions relating to the ethics of the profession and to the activities of unqualified individuals who attempt veterinary practice. Its functions thus amount to the maintenance of a high degree of professional efficiency and ethical conduct among its members. For some years the Council of the Royal College of Veterinary Surgeons has required the veterinary, like the medical, student to complete a training lasting five years; in this time he has to cover a field of work similar to, but wider in scope than, that covered by the medical man. When he has received the veterinary diploma (M.R.C.V.S.), the veterinary surgeon can, if he likes, take, under suitable conditions, such additional qualifications as the fellowship of the Royal College (F.R.C.V.S.) or the diploma in State veterinary medicine (D.V.S.M.), which are awarded by the Royal College alone, the diploma in tropical veterinary medicine (D.T.V.M.) awarded by the University of Edinburgh, or various postgraduate courses which are designed to give further instruction in pathology, bacteriology and public health, or to give special instruction to those who wish to enter the Royal Army Veterinary Corps or the Colonial Veterinary Services. Some universities also grant degrees in veterinary science, and the D.Sc. and Ph.D. are open to veterinary surgeons doing research in some universities. It is no new thing, either, for chemists, biologists and others to take advantage of the grants provided by the Ministry of Agriculture to become veterinarians as well.

In addition to these opportunities to advance his education and broaden his outlook, the modern veterinarian may look for aid to the funds and wise direction of the Veterinary Educational Trust. This trust, which was founded in 1942, was the subject of a leading article in these columns at that time (NATURE, **150**, 500; 1942). We then commended the aims of its founders, namely, the creation of an animal health organization, together with the provision of scholarships, fellowships and other aids which would do much to provide veterinarians with adequate education and opportunities to do their work; for the veterinarian is, we then insisted, one of the key men in our national affairs. *The Times*, *The Field*, the *Farmer's Weekly* and other far-seeing and well-informed authorities agreed with us then

that the new type of veterinarian who has come into the field must have the best possible training and mental equipment. Great Britain must no longer be reproached, as it is still being reproached, for its continued failure to accord to its veterinarians the status and educational facilities which are provided as a matter of course by other countries.

This brief outline of the existing veterinary education will, however, make it clear that events are moving slowly in the direction advocated in the leading article already referred to. Veterinary education is still too far divorced from the universities, but a nucleus of close collaboration with them exists; the existing system segregates the veterinary student and the qualified veterinarian from university workers, but it ensures a uniform standard in its examinations, and this is denied to the medical man and to some other professions. Whether this uniformity is worth the price paid for it in the dissociation, not only of veterinary students, but also of their teachers, from university life and work it is not our purpose to consider. It is pertinent, however, to direct attention to one aspect of this dissociation—its tendency to hinder the natural contacts between the work of the veterinary surgeon and that of the medical man.

Upon this point and upon the desirability of drawing together these two great professions by means of some educational scheme a great deal could be said by those veterinary surgeons and medical men who agree that it could do nothing but benefit both professions. No other professions are so closely connected as these. Both study the normal and deranged health of animals; both are concerned with the control of diseases which, like tuberculosis, trypanosomiasis, anthrax and others, are communicated to man from his domesticated animals; both are concerned with the production, in adequate quantity and quality and in freedom from disease, of basic foods such as eggs, milk and meat; both have made outstanding contributions to our knowledge of animal morphology, physiology and pathology and to bacteriology and the control of disease. Some men have, indeed, expressed their realization of the common aims of the two professions by acquiring the qualifications necessary to both; and the Royal Society of Medicine, when it established a section of comparative medicine, the proceedings of which are conducted jointly by medical men and veterinary surgeons, expressed its belief in the close co-operation of these two professions.

This co-operation, like the general collaboration between the veterinary surgeon and workers in other branches of scientific inquiry to which we have already referred, is, in fact, increasing in our chief centres of teaching and research. It is not, however, close enough. It ought to be an active, natural liaison. We say liaison because no one would propose that a closer association than this is possible. It would not be possible, even if it could be shown to be desirable, to educate the two professions in the same classes. The first year of their instruction can be so passed. In point of fact, in Edinburgh all students of Surgeons Hall and of the Dental College of Edinburgh are, at the request of their respective deans, doing their first-year physiology, histology and biochemistry at the Royal (Dick) Veterinary College during the War; but as soon as the student goes on to the study of anatomy and physiology, the special requirements and wider scope of the veterinary course make it necessary to give him special classes in the anatomy and physiology of the domesticated animals. He requires to know how to manage and care for these animals; and this is, in itself, a big undertaking, requiring the provision of a farm and a field station; it is, indeed, one of the major difficulties of veterinary education to-day. The veterinary student further requires, as his instruction proceeds, more and more instruction over and above that given to the medical student, who deals with one kind of animal only. No medical school could, for example, provide the clinical material which is essential for the teaching of the diagnosis and treatment, whether this be medical or surgical, of sick animals and for the teaching of veterinary obstetrics. The provision of this essential clinical material is, in fact, another major difficulty of modern veterinary education. It calls for the provision of veterinary hospitals at every veterinary teaching centre. It must be obvious that efficient veterinary education requires its own specially trained teachers and its own independent buildings. This need not mean, however, that an administrative scheme could not realize a close association between the students preparing to enter both the medical and the veterinary profession. It could with advantage require that medical and veterinary students should each utilize to the full the courses of instruction given to the other.

We thus reach the natural culmination of that educational process which began with the foundation of the veterinary teaching colleges. At the present moment the Loveday Committee is reconsidering on behalf of the Government the recommendations it made in 1938 for the improvement of veterinary education; at the same time the country is being told by the medical and lay Press something of the profound re-organization of the medical profession which is in progress. It is true that this medical reorganization appears on the surface to affect chiefly the practical treatment by the doctor of his patients, but it would be short-sighted to suppose that a revolution in practice of this order will not affect profoundly the education and, indeed, the whole outlook of the medical man. He is to become, it is clear, much more of a public servant and much less of an individual who practises, with whatever nobility of purpose, for his own private profit. It may be that a similar change will affect all of us, in one degree or another. The veterinary surgeon is already able to do public service by entering the Colonial veterinary services or the State veterinary service at home.

While changes so fundamental are being considered and planned in both the veterinary and the medical professions, it must surely be wise to consider also whether their education, at least, if not their practice, cannot be planned as a natural whole. Their basis

is the same, their principles are the same, so the end product of their education should be the same. Both professions should study to produce an alert, scientific, public-minded individual whose altruistic outlook moves him to choose as his life-work the science and art which seeks to relieve the sufferings of man and animals and to save their lives when they are attacked by disease. The best way of doing this is, as was pointed out in our leading article a year ago, to study to prevent the occurrence of disease rather than to try to cure it after it has occurred; and this is, in fact, the policy of both the veterinarian and the medical man of to-day. It would be difficult to find a better or a more powerful bond between them. In tune as it is with the whole trend of modern thought, it may well prove to be the only bond which is powerful enough to compose the differences which undoubtedly still exist between these two great professions.

SCIENCE AND RELIGION

Man, Real and Ideal

Observations and Reflections on Man's Nature, Development and Destiny. By Prof. Edwin Grant Conklin. Pp. xvii+247. (D.800.) (New York and London: C. Scribner's Sons, 1943.) 2.50 dollars.

PROF. CONKLIN'S book is well intentioned and well written, but, at least to me, profoundly unsatisfactory. The theme is, in the main, the time-honoured problem of the relation between science and religion, and it would be near the truth to say that, for the author, real man is man as science discloses him, while ideal man falls in the province of religion. Prof. Conklin evidently writes for a public which is still not unaffected by Fundamentalism, for echoes of the Tennessee controversy over evolution lend some of his remarks an asperity which English readers will consider strange. But the pages in which he outlines the evolution of man and the origin of races are clear and easy to understand by the general reader. They call for no comment except recognition of their admirable lucidity. He concludes that "the main direction of human progress has turned from the path of further differentiation of the individual to that of increasing differentiation and integration of society".

In spite of Prof. Conklin's exposition, I remain, as often, perplexed by the word 'evolution'. It seems to me that evolution is not a fact in the sense that it is a datum, but a theory to explain a large number of observed phenomena. What precisely the author's theory may be I find it impossible to say. He is certainly not a thoroughgoing Darwinian. Chance mutations and natural selection are not enough; there is an "unknown factor" in evolution, which appears to be more important than the known factors. All that the author will say about it is the somewhat vague question, "Is it unreasonable to suppose that something basic to intelligence and purpose is found in all organic evolution?" It will not surprise the reader who has made anything of this question that Prof. Conklin believes in a "non-personal" teleological tendency on which he builds rather more than the foundation will stand.

Behaviourism finds no favour with the author, who says, truly enough, that "to deny the reality of subjective phenomena is equivalent to denying the reality of all phenomena", and he inclines to the belief, or should we rather say hope, that divine immanence is the assumption which will maintain something like divine control or direction in evolution without conflicting with science. It is not, I think, unfair to say that when Prof. Conklin comes to deal with metaphysical problems his clearness of thought is obscured and we have the impression that he has not thought the meaning of his assertions through to the end. Thus he calls himself a "scientific realist" and he defines his attitude as follows: "I regard the external world as real and I think that objects are what they seem to be unless by scientific methods it can be shown that they are otherwise". The naïvety of this sentence disarms criticism, but it must be pointed out that almost every word in it raises epistemological problems of the most far-reaching character. We cannot stay on them, but it may at least be remarked that the further "scientific methods" are pushed the nearer we come to the position that *no* objects are "what they seem to be". Nor again can the assertion that idealist metaphysics "denies objective reality and therewith all science" be passed over without protest. The truth is that most idealist theories of the ultimate nature of reality leave science precisely where it was.

Perhaps it is useless to protest against the unscientific attitude adopted in this book to psychical research, because it is so common among scientific writers. Prof. Conklin believes that there is no scientific evidence in favour of personal survival of death, and states, no doubt accurately, that "the anecdotal evidence of psychical research leaves most scientists cold and unconvinced". This is merely an appeal to authority and not the result of an examination of the data, and surely no one who had followed the recent development of psychical research, for example, in the field of extra-sensory perception, could employ the epithet 'anecdotal'.

These are criticisms of detail, though I think of important detail, but it is not upon them that I base the opinion that the book is disappointing. Prof. Conklin has a real respect for religion and a keen perception of its place in human life. He writes eloquently of the pessimism of the 'pure realist' who allows no right to the religious experience. He is deeply concerned for the future of mankind and the preservation of ideal ends in life. He has a sincere reverence for the character and teaching of Jesus. No one could read what he has to say on these subjects without emotion and a feeling of affection for the author. But what does the religion which remains, when realism has done its work, amount to? I cannot see that it comes to anything more than the belief that possibly the hypothesis of God may be, in some undefined sense, true, that there are rather dubious signs of an immanent purpose in evolution, and that, if we all work very hard and keep our ideals bright, we may possibly produce a better world for our great-grandchildren. This will never do. If this is all that religion has of truth it will disappear. The root error of the book is the sharp distinction between reason and emotion and the relegation of religion to the emotional sphere. Religion has always claimed to be 'wisdom', to have an insight into the meaning of the world on which it stands or falls. The fundamental problem is never touched on in this book—the nature of scientific knowledge and its relation to other types of knowing.

Though I regard the book as, in its chief theme, superficial, I would not imply that it is not worth

reading, for it contains much incidental wisdom, mainly of a practical kind. I will conclude by quoting some sentences which express a truth needing to be emphasized. "It is time for some statesman or philosopher, some modern Plato, to draw up a Bill of Duties to match and balance our Bill of Rights. It is said that society owes every man a living, leisure, opportunity, freedom, but there is less emphasis upon what every man owes to society. There are no human rights that have not been earned by human effort, no social rights that are not balanced against social duties". W. R. MATTHEWS.

PROF. MOORE AND PHILOSOPHY

The Philosophy of G. E. Moore

Edited by Paul Arthur Schilpp. (The Library of Living Philosophers, Vol. 4.) Pp. xvi+717. (Evanston and Chicago: Northwestern University; London: Cambridge University Press, 1942.) 30*s.* net.

THIS book tries to reproduce the conditions of a seminar. There is a common theme: the philosophy of G. E. Moore; there are nineteen philosophers, considering, interpreting and criticizing Moore's presuppositions, approach and philosophic method—both in general and in the specific cases of ethics and the theory of perception; there is, finally, a lengthy answer by Prof. Moore in which he takes up some of the points raised and deals with them with particular relish for fine detail, avoiding, however, treatment of more general problems.

The nineteen essays seem quite independent of each other. None of the authors appears to have had the opportunity of taking account of the content of other contributions. I do not suggest that an agreement about views and a fusion of the exposition would have been desirable; but, if collaboration had been possible, some repetition of arguments in the five hundred pages of criticism might have been avoided and a more connected vision of Moore's philosophy achieved. The lack of collaboration is probably due to quite external circumstances, but the nature of Prof. Moore's reply cannot be thus accounted for. I cannot be alone in my poignant regret that G. E. Moore, after fifty years of philosophizing, embodied in reviews, essays, lectures and only one full-length book, did not give us—instead of a hundred and fifty pages of disconnected detail—a systematic account of his present philosophic position.

But I may be asking for the wrong thing. Perhaps it is not paradoxical to suggest in the face of this very voluminous book called "The Philosophy of G. E. Moore" that there is no such thing as the philosophy of G. E. Moore. There is indeed something: the attitude of G. E. Moore, and G. E. Moore's doubts, even bewilderment, about different philosophies. Something, I think, must here be said about this attitude. But I cannot hope to reproduce in a few words any of the important and penetrating things said by experts in this volume; nor dare I, without the opportunity for elaborate reasoning, contradict their points.

This book also contains an important weapon for the criticism of Moore's philosophic attitude, namely, his autobiography. This weapon, I suppose, has not been at the disposal of his nineteen critics. There is a method of philosophic criticism which is perhaps not universally recognized as fair and relevant; it is Nietzsche's 'unmasking'; that is, the tracing back of philosophic views to personal attitudes. If the autobiography—unlike the photographs included—is instrumental to the work's main purpose of philosophic elucidation, it can only suggest this method. If I seem to administer a kick from behind, I must insist that I have been specially led to take up this position. I quote an illuminating passage from the autobiography: "I do not think that the world or the sciences would ever have suggested to me any philosophic problems. What has suggested philosophic problems to me are things which other philosophers have said about the world or the sciences . . . first, the problem of trying to get really clear as to what on earth a given philosopher *meant* by something which he said, and, secondly, the problem of discovering what really satisfactory reasons there are for supposing that what he meant was true, or alternatively, was false".

I think that Moore's unwillingness to give an author the benefit of the doubt or to try to see—behind the inevitable misuse of language and the cramping effort of philosophic creation—that important insight and satisfactory vision flows from the attitude expressed in the quotation. It is from this point of view that he insists that he does not understand unless he is told in plain English. (Thus, for example, his surprising refusal to understand the word 'postulate' and therefore Mr. Edel's essay.) He is more interested in the minute inconsistencies of terminology than in the broad issues of which they are the vehicle.

Equally his defence of common sense flows from his preference for criticism to philosophic creation. While a defence of common sense may be a salutary corrective to some rash philosophic views, an imaginative conception of philosophy will not see in common sense an independent criterion, but only the popularized philosophy of the day before yesterday.

A different yet connected aspect of Moore's attitude is his position as reviver of 'realism'. I suggest that 'realism' as much as 'idealism' flows from, and is in an important sense largely an expression of, an experience of the way in which a mind works. This is certainly less than the last word about those philosophic schools, but perhaps more than an empirical statement of psychology. Moore's incapacity for, or mistrust of, creative speculation has led him to resign the claim of the mind-dependence of the world, just as Bradley's exuberance of creative force which speaks through his style and imagery tempted him into the elevation of mind to despotic power.

I have no space in which to make fully explicit the presuppositions of my approach. I have not undertaken to decide about the truth of philosophies or to pass value judgments upon them. It is perhaps obvious from my account that I believe much of Prof. Moore's approach futile. But it would be both useless and improper to assert a judgment without the opportunity for a full exposition of reasons. Only the utility of the whole work is here under consideration.

Moore's is a distinctive philosophic attitude which has exercised considerable influence. The critical consideration of this attitude and the ramifications symptomatic of its influence, together with his reply, certainly represents an important document about the state of philosophy in our time, and is rich in suggestions for the future critical historian of twentieth-century philosophy. H. P. REICHMANN.

PENICILLIN: ITS DEVELOPMENT FOR MEDICAL USES*

By PROF. H. W. FLOREY, F.R.S.
University of Oxford

PENICILLIN has received a great deal of publicity in the lay Press during the last year or two, largely, I suspect, because of the somewhat unusual and dramatic circumstances of its discovery and development. Though some of the accounts are substantially correct, others, both British and American, have not been so reliable.

It has been known since Pasteur described the phenomenon in 1877 that in a test tube in the laboratory, the growth of one species of bacterium may be stopped by the concomitant growth of another. It is now known that this is due to the production by the antagonistic micro-organism of a definite chemical product. To these naturally produced chemical inhibitors, the name of 'antibiotic' has recently been given. Pasteur recognized that the phenomenon of antibiosis might be of use in therapeutics, but the first serious attempt to use it was made by Emmerich and Loew in 1899, when they suggested that the products of a common micro-organism, *B. pyocyaneus*, could be used for treating anthrax and diphtheria. It is certainly true that this bacillus produces more than one antibiotic, but the mixture called 'pyocyanase' has never really been shown to be of use in medicine.

In the course of years, many examples of the production of antibiotics were found; in fact in 1929 a monograph was published about them, but none had at that time been employed successfully in medicine.

Discovery of Penicillin

In 1929, Prof. A. Fleming, of St. Mary's Hospital, London, made a very acute observation. He was examining the growth and properties of Staphylococcus. This organism grows readily on a solid medium containing agar. In the course of his observations, Fleming had to lift the lid on and off in order to examine the staphylococci growing in the dish. Now everywhere in the air around us are bacteria and spores of moulds. If the lid of an agar plate is left off for only a few minutes, bacteria and spores settle on the agar and in a few days the surface is covered with a thick growth of bacteria and moulds. During Fleming's short manipulations, a mould spore settled on his agar plate, which was then put aside for a few days. Such a contamination is extremely common, but what was remarkable in this instance was fortunately noticed by Fleming, who had for many years been interested in antiseptics. Around the mould colony, the colonies of staphylococci were undergoing lysis, that is, dissolving.

Fleming took some of the mould and cultivated it in flasks, in liquid broth. He found that during its growth something appeared in the broth which was capable of inhibiting the growth of a number of microbes, including many of those which cause some of the most destructive lesions the flesh is heir to. This substance Fleming called 'penicillin'. The mould was afterwards identified as *Penicillium notatum*. It is not a common mould, and is not the kind found on bread, old boots and such-like.

Fleming found that penicillin-containing broth was not more poisonous to animals than ordinary broth, and that the broth did not appear to harm white blood cells. He recognized that penicillin might be of value in medicine as an antiseptic to apply to infected wounds, and after treating a few indolent septic wounds with the broth, he concluded that, as he said, "it certainly appeared to be superior to dressings containing potent chemicals".

Clutterbuck, Lovell and Raistrick found in 1932 that the mould could be grown on a purely synthetic liquid medium, but they did not succeed in extracting the penicillin from the liquid in stable form. They found, however, that if the medium was acidified and shaken with ether, the penicillin passed into the ether. Unfortunately, when they tried to get rid of the ether and concentrate the penicillin by evaporation, most of the penicillin activity was lost.

Discovery of the Chemotherapeutic Effects of Penicillin

Fleming, and also Clutterbuck, Lovell and Raistrick, concluded that penicillin is a very unstable substance and therefore not likely to be a practicable antiseptic, and the matter rested there until the work was taken up at the School of Pathology, Oxford, in 1939. Since 1929, I had been interested in another discovery of Fleming's—lysozyme—a substance occurring in many animal tissues and secretions which has the power of dissolving certain air bacteria, though unfortunately none which produces disease. The work on lysozyme was continued on the biochemical side during the 1930's, until it was purified by Roberts in 1937, and the material or substrate on which it acted characterized by Epstein and Chain in 1940. During the latter part of this work in 1938, Dr. Chain and I decided that it would be profitable to make a systematic survey of naturally produced antibacterial substances both from a biochemical and biological aspect. The first two to be investigated were the products of *B. pyocyaneus*, the bacterium to which I have already referred, and penicillin. Penicillin was chosen (in spite of the fact that it was said to be very unstable) because it acted against disease-producing bacteria, in particular the staphylococcus. One observation of Fleming and of Clutterbuck, Lovell and Raistrick suggested that penicillin was not too unstable to handle; that was, that its activity might, under certain conditions, be maintained in the original medium for some weeks. At the beginning of the work we thought that penicillin would be an enzyme or ferment like lysozyme, and we were certainly unprepared to discover its remarkable properties which came to light in the course of the investigations. The work which we now began needed the close collaboration of many workers. In addition to Dr. E. Chain, these colleagues have been Dr. E. P. Abraham, Prof. A. D. Gardner, Dr. N. G. Heatley, Dr. M. A. Jennings, Dr. A. G. Sanders, Dr. C. M. Fletcher and Mrs. Florey, with the collab-

* Substance of a Friday discourse delivered at the Royal Institution on December 10.

oration of many surgeons and physicians; I should like to emphasize that without their unstinted efforts the work would never have been carried through to its present stage. Nor must one forget how much was due to our technical assistants, Mr. G. Glister and his 'penicillin girls', Mr. J. Kent and, for the chemical work, Mr. D. Callow.

One of the first steps was the elaboration by Heatley of a quick test for penicillin, which made the quick assay of penicillin-containing fluids possible.

At first the mould was grown in flasks; later, when more material was required, it was grown in larger vessels.

Preliminary experiments showed that penicillin was an acid which in the acid form rapidly lost its activity. It was also destroyed by alkali but was stable at a point which was neither acid nor alkaline, that is, about neutrality. Further, Clutterbuck, Lovell and Raistrick's observation was confirmed that, if penicillin-containing brew was made acid and shaken with ether, the penicillin passed into the ether. The crucial observation was then made that when the ether containing penicillin was shaken with water containing the right amount of alkali, the penicillin passed from the ether back into water. In this way the penicillin could be extracted from the crude brew and partially purified. The processes now used for the preparation of penicillin all depend, at one stage or another, on transference of penicillin from a water solution to an organic solvent and back.

It must be realized that in the early days we had very little penicillin for the experimental work on which some of the essential chemical data were obtained. The main factors affecting the use of penicillin in medicine are that salts of penicillin: (1) are stable about neutrality; (2) they are destroyed by acid and alkalis; (3) by oxidizing agents such as potassium permanganate; (4) by certain metals such as copper, lead and mercury; (5) by some alcohols; and (6) by enzymes or ferments produced by certain air bacteria.

One of the most important points is its destruction by an enzyme or ferment produced by certain air bacteria. These bacteria are ubiquitous and very easily contaminate the fluids in which penicillin is grown. If this occurs, the enzyme produced by the bacteria destroy the penicillin as fast as the mould produces it. It is, in fact, the air bacteria which make large-scale production of penicillin so difficult, for it is by no means easy to carry out manipulations on a large scale while excluding these organisms.

The isolation from the original medium of a protein- and salt-free product made possible a study of the bacteriological and pharmacological properties in detail.

Some of the bacteria highly susceptible to penicillin are *Streptococcus pyogenes* (causing pus formation and such diseases as child-bed fever), *Staphylococcus aureus* (causing bone diseases and boils, etc.), both of which are important in war wounds, *Streptococcus pneumoniæ* (causing pneumonia), *Corynebacterium diphtheriæ* (causing diphtheria), *Clostridium welchii*, *septique* and *œdematiens* (causing gas gangrene), *Neisseria gonorrhœæ* (causing gonorrhœa), *Neisseria meningitidis* (causing meningitis or spotted fever).

Some much less sensitive are those causing typhoid fever and a form of food poisoning, while some, such as those causing plague, cholera, dysentery and tuberculosis, are quite insensitive. It is thus clear that penicillin is not a cure-all, and it cannot be expected to act except in diseases caused by susceptible organisms.

Most antiseptics, like carbolic acid, kill the germs outright; but penicillin merely stops their growth, that is, it is what is called a bacteriostatic. It interferes in some way not yet clear with bacterial division.

Some of the first material produced inhibited the growth of an organism such as the streptococcus at a dilution of 1 : 1,000,000. We made the erroneous deduction that anything so powerful as this must be fairly pure, but we now know that only about 1 to 2 per cent of the original brown powder was pure penicillin. What is now commonly called penicillin for use in medicine still contains not more than 10–20 per cent of the active material, the rest being coloured and other impurities.

Pharmacological Properties

While this chemical and bacteriological work was proceeding, investigations were also made on its pharmacological properties. The most important points are: (1) lack of toxicity to mice and other animals; (2) white blood cells (leucocytes) and tissue cultures (body cells grown in glass vessels) are unaffected by concentrations of penicillin some hundred of times greater than that necessary to stop bacterial growth; (3) the activity of penicillin is not affected by pus, blood or the breakdown products of dead tissues; (4) its activity is little affected by the number of bacteria present; (5) it is absorbed after injection into muscle or beneath the skin and from the small intestine; (6) it cannot be given by stomach owing to the presence of acid there, nor by the large bowel owing to the presence of bacteria which destroy it; (7) it is very rapidly excreted by the urine, hence large and frequent doses have to be given. It is also excreted in the bile.

Points 3 and 4 are in sharp contrast to the sulphonamides.

It is most important that penicillin has little effect on the white blood cells or leucocytes, for it is to these that we owe a great deal of the capacity of the body to combat infection. If germs gain entrance, say, through a prick in the finger, the blood vessels dilate and certain of the white blood cells emigrate from the blood vessels to the tissues. They move freely about in the tissues, where they take up and kill bacteria if they meet them. But the bacteria produce poisons which kill the white blood cells, and the outcome of the infection is to a large extent controlled by which factor is the greater—the killing of the leucocytes by the bacteria or vice versa.

It will now be appreciated how penicillin acts in combating bacteria which have gained entry to the body. It stops the growth of the germs, while the white blood cells ingest them and kill them off.

The final experiments which demonstrated that penicillin might be useful in medicine were those known as mouse protection experiments. A number of mice are inoculated with germs which will certainly kill them if no successful treatment is given. We sat up through the night injecting penicillin every three hours into the treated group, and I must confess that it was one of the more exciting moments when we found in the morning that all the untreated mice were dead and all the penicillin-treated ones alive. The diseases treated experimentally were

caused by the streptococcus, the staphylococcus and a gas gangrene organism. Against the latter two organisms there is no other really effective drug.

A man is roughly 3,000 times the weight of a mouse, so you can well imagine that the next step, to produce enough to use on man, took months of labour on the scale at which we were then working. Eventually enough was made to give a single small injection to a man. Much to our consternation, the patient started shivering and the temperature rose. Fortunately, the substance causing this reaction was not penicillin, and the impurity was removed quite easily by chemical means.

Work in the laboratory having provided all the necessary knowledge to enable us to say penicillin could be used on man, and what sort of infections it was likely to deal with, the object of the first trials on man was to see if the drug exhibited any toxicity not found in animals and to ascertain the best methods of administration and the necessary dosage.

Penicillin can be used in two ways; it can be injected intravenously or intramuscularly, after which it is carried by the blood stream to the diseased parts. By this means much penicillin has to be used, but it is the only possible way of giving it in many serious illnesses. It may also be used in much less quantities as a local application to infected parts. Its successful use locally clearly depends on being able to reach every part of the diseased area, and one of the main points in its use is the elaboration of the requisite surgical techniques to ensure this.

There is no question that this drug can perform in a remarkable way when rightly used but, as with all new drugs, the initial trials tend to be carried out on what are considered hopeless cases after everything else has been tried. Though it is recognized now that penicillin is a valuable drug, it is still so rare that patients are not treated until the disease has progressed a long way and everything else has been tried. What one looks forward to is its use at the earliest possible moment with the idea of stopping or preventing destruction of the tissues, and so saving much disability and prolonged illness, and even life. It is probably along these lines of prevention, for example, that it will be most profitable to use the material for those wounded in battle.

At the present time there are dozens of chemists both in Great Britain and in the United States, in academic laboratories and commercial firms, engaged on the chemical problems, and we must await the result of their labours with what patience we can. In the meantime, great efforts are being made to improve the yields produced by the mould by means of selecting a good specimen or strain of the mould, and by improving the media. A considerable measure of success has been achieved, particularly by our American colleagues. Just as the Americans have had our information we have theirs, and commercial firms both in Great Britain and America are now doing all they can to make this drug available in quantity in the shortest possible time.

I venture to suggest that in another five or ten years the work I have been describing will be looked on as the first halting steps in the exploration of a whole series of new chemotherapeutic compounds, and I think the discovery and development of penicillin may be looked on as quite one of the luckiest accidents that have occurred in medicine, for without exception all other mould antibiotics so far examined are poisonous.

INFLUENCE OF NEWTON'S WORK ON SCIENTIFIC THOUGHT*

By N. TEICH,
University of Leeds

BY his extraordinary talent Newton was able not only to produce a powerful synthesis of the work done by his immediate predecessors, Galileo and Kepler, but also to add profound contributions of his own to mechanics, mathematics and optics. His method of fluxions enabled him to produce quantitative calculations which raised the level of mechanical science to hitherto unknown heights. The mechanical interpretation of Nature to which he gave such a powerful stimulus became one of the leading factors in the subsequent development of scientific thought.

The question arises now whether it is possible in discussing the scientific side of Newton's influence to omit his influence on the philosophical and social side? Evolution of scientific thought does not depend only on experiments and calculations. It is true that scientific men are in the first place responsible for scientific thought. But they do not live in a vacuum. They are social beings; they take part consciously or unconsciously in the life of society surrounding them. Social ideas which agitate society also affect their ideas.

What was the social background to which we have to look in order to understand the essential levers of Newton's work? Whoever takes a plunge into the history of Newton's period cannot help observing that the intellectual activities of Newton and his contemporaries went side by side with the struggle for political rights between the old nobility and the rising class of merchants. All activities in military and commercial spheres needed the active help of people well versed in the theoretical principles of astronomy (for navigation) and of mechanics (for building simple machines or using cannons). It is not surprising, therefore, that the physical theory of that time occupied itself mainly with the motions of stars or of bodies encountered in everyday experience. People needed scientific knowledge in order to improve their living. What Francis Bacon hoped for when he said that "the roads of human power and human knowledge lie close together" became a reality more than ever before at the time of Newton in England, and at the end of the eighteenth century in France. It is no accident that the essentially materialistic conception of mechanical science scored such a profound victory first in England, then in France, because in these countries the social changes which we associate with the bourgeois revolutions of 1642 and 1789 were favourable to a materialistic philosophy.

Although the immediate social impacts gave rise to the comprehensive theory and practice of mechanics as worked out by Newton, we must not forget the historical continuity which binds the Newtonian outlook to the earlier English materialists, Roger Bacon and Francis Bacon, and to the schoolmen Duns Scotus and William of Occam. English materialistic thought culminated in Newton's work in mechanical science despite the theological limitation Newton imposed on himself.

The brilliant success of Newton's work as applied

* Essay awarded the Foyle Prize of the University of Leeds.

to practical problems of everyday life accounts for the widespread use of mechanical interpretation in nearly every field of human knowledge. Thus David Hartley, the social investigator, in order to justify his own method of approach said: "The proper method of philosophizing seems to be, to discover and establish the general laws of action affecting the subject under consideration under certain select, well defined and well attested phenomena, and then to explain, and predict the other phenomena by these laws. This is the method of analysis and synthesis recommended and followed by Sir Isaac Newton."

At this juncture it might, perhaps, not be out of place to turn to the relation of philosophy to science. Broadly speaking, philosophy at every stage of its development has reflected on Nature, and by proposing a comprehensive view of it has pretended to know it. Although philosophy has often abandoned reality—and thus Nature, the object of its study—we have to give it credit, at any rate, for posing the question of evolution earlier than natural science. Thus the great German philosopher Kant tackled the origin and constitution of the solar system forty years before Laplace. Natural science arose just because official philosophy came increasingly into conflict with everyday experience. Afterwards it became apparent that natural science was taking over one domain after another considered to be under the jurisdiction of philosophy. This development reflected itself in the division of science into physics, chemistry, biology and other branches. This division, of course, was inevitable in view of the complex processes which characterize natural phenomena. Precisely because of this complexity, scientific men were initially unable to see processes in Nature but only phenomena in isolation. In this light we have to see the development of mechanics as a well-defined science, the subject of which was particles in isolation connected only by forces. By the mid-nineteenth century enough was known of natural phenomena to show that they constituted continuously changing processes. Knowledge of these processes through natural science alone was able to give a relatively full picture of Nature. A special knowledge through philosophy could be dispensed with. However, Kant's 'thing-in-itself' lay equally heavy on philosophers and men of science. Thus actually science and philosophy continued to exist side by side, sometimes in mutual opposition, sometimes in mutual support, of each other's theories.

The request for the support of science is a sign of progressive thought. In eighteenth-century France, the absolute monarchy was being undermined by the demands of the middle classes for political rights. Great and daring writers reflected in their publications the approaching storm of the Great Revolution. For our purpose it is important to note that these writers philosophically reared by Descartes based their arguments on science, which meant the mechanical science brought to the highest pitch of perfection by Sir Isaac Newton. The precision by which his theoretical calculations were proved when applied to everyday practice created an atmosphere of confidence as much in scientific as among political circles.

Descartes postulated mechanical science as the focal point of the interpretation of Nature, and Newton demonstrated by actual calculations and experiments the truth of this new scientific thought. Descartes came to the conclusion that mind and matter were separate; Newton through his unrivalled authority in the fields of mathematics and mechanics gave it a form of Papal blessing, showing that the world was able to live on its own, having been given the famous external impulse by a being whom Newton identified with God. The ripest fruit of this Cartesian-Newtonian interaction is perhaps LaMettrie's work "Man the Machine".

The social ferment in France gave rise to a thirst for knowledge. We witness a spread of scientific education, primarily concentrated in artillery schools. Laplace and Lagrange, perhaps the most brilliant Newtonians, were pupils in these schools. Laplace, though as a whole following Newton, was the first to apply mathematics to the problem of the origin of the solar system, which Newton probably considered to be outside scientific investigation. But even his authority could not prevent searching minds thinking about it, because it was realized, if only vaguely, that since everything around changed and developed, there must be some rational origin of the solar system. Incidentally, the Kant-Laplace nebular hypothesis was to be a stepping-stone for geologists to start work on the origin of the earth.

In his attempt to explain natural phenomena Lagrange followed a similar line in his "Mécanique analitique" published in 1787. Newton's "Principia" was published exactly a hundred years earlier. Whitehead points out that these hundred years contained the first period of mathematical physics of the modern type, and that the publication of Clerk Maxwell's "Electricity and Magnetism" in 1873 marked the close of the second period. He thinks that "each of these three books introduces new horizons of thought affecting everything which comes after them".

Though highly mathematical and abstract, these books express the technical and practical problems of the day. Thus it is often said that Clerk Maxwell translated Faraday's work into mathematical language; and Faraday's work was mainly connected with electrochemistry and electromagnetic induction, both of primary importance in industrial practice. It is not without reason that the authors of the above-mentioned books were in the order: Englishman, Frenchman, Englishman. The order reflects the comparative historic importance of their respective countries in the political and economic development of Europe.

With Clerk Maxwell we find ourselves in the nineteenth century. What was the social background of England at that time? Previously, small-scale enterprise developed into factories. England became the workshop of the world. Great problems of power supply and its measurement arose. Such is the social framework into which we have to fit Faraday's work on transformation of mechanical energy into electrical, or Joule's measurements of the mechanical equivalent of heat. A tremendous drive in industrialization was largely possible, because the preliminary scientific discoveries based on the work of Newton and his immediate successors were available. But the industrial revolution begot new scientific problems of its own. For our purpose it is important to note that the scientific men of this time were gradually ceasing to preoccupy themselves with particles and matter, and shifted their interests to fields and energies. We have seen already that Newtonian rigid mechanical assumptions were not accepted unconditionally. Hence the emergence of the Kant-

Laplace theory. In this century physical thought departed more and more from the Newtonian mechanical view. Physicists, in order to describe reality in a profounder fashion, were turning their eyes to the environment of the particles—to the fields which they considered to be stores of energy.

Initially, at this stage, physicists, moulded in Newtonian mechanics, explained energetic phenomena mechanically. The great German scientist Helmholtz expressed it in these words: "The final goal of all natural science is to develop into mechanics". Thus heat energy was recognized to be the outcome of the motion of molecules of matter. Maxwell's mathematical equations provided an all-embracing theory of optics and electromagnetism. Still influenced by the mechanical interpretation of Nature, men of science tried to find a material medium for the propagation of electromagnetic waves. Rapidly advancing scientific technology gave birth to fine instruments which showed a discrepancy between theory and experiment. The medium for wave motion—ether—endowed with many directly opposite qualities, had to be abandoned after the Morley-Michelson experiment failed to prove its existence. The mechanical view receded gradually into the background of the study of dead matter, whereas in biology it was rather unsuccessfully sustained, mainly by the Germans Vogt and Büchner.

From closer study of the history of science it can be seen that scientific advance is not a smooth progress, but takes a somewhat zigzag path. It is continuous and discontinuous at the same time. At any time scientific ideas embody in themselves many older, together with newer, views. Newton's influence in this period was of such a nature. He had been disproved in the question of corpuscular theory of light by Young and Fresnel, he had been looked upon sceptically by those to whom a mechanical method of interpretation of Nature seemed to be incorrect. On the other hand, his general concept of absolute space and time was unchallenged and tacitly assumed. The main function of his space seemed to be to transmit waves of electromagnetic nature of various frequencies, that is, to transmit energy essentially devoid of matter.

In the eighteenth century scientific men believed with Newton that the world was filled with particles, some ponderable, some imponderable. This mechanical view was opposed by the nineteenth-century physicists when applied to the corpuscular theory of light, on account of its inability to explain satisfactorily the interference of light. The corpuscular theory and the wave theory had competed for the favour of physicists since the time of Newton and Huygens and seemed to be irreconcilable. Suddenly, in the early part of the twentieth century, it was discovered that light may possess both properties. As Einstein and Infeld write: "No one thought of applying this concept [that is, the concept of energy] to the corpuscular theory of light. Newton's theory was dead and until our own century its revival was not taken seriously."

The reconciliation was the outcome of a suggestion put forward by Planck to explain certain experimental results in radiation problems. Introducing the elementary quantum of energy, he proposed the atomization of energy. The scientific world was faced with the dilemma of regarding energy as discontinuous after having for a long time considered it to be continuous. Einstein elaborated Planck's suggestion with respect to light energy, when he revived Newton's light corpuscles in his shower of photons or quanta of light energy. If Einstein, on one hand, brought Newton to the fore again, on the other he became aware of the limitations of Newtonian hypotheses. The contradictions in the Newtonian system evolved gradually, aided by the new scientific technique. Thus Einstein and Infeld write: "The theory of relativity arises from the field problems. The contradictions and inconsistencies of the old theory forced us to ascribe new properties to the time-space continuum, to the scene of all events in our physical world." Einstein, in proposing this revolutionary theory, utilized the great advances in physical theory and practice made since Newton. As the field theories are connected with Newton's mechanics, so the relativity theory is connected with field problems. In both cases this close connexion does not preclude the emergence of an essentially new picture of the working of natural phenomena. Thus the new phase of physics includes Newton's physics as part of a more general and richer physical theory corresponding to the new experimental facts.

The formulation of the law of conservation of mass is perhaps the most general reflexion of the mechanical thought which permeated the eighteenth century, when scientific workers were influenced by the thought expressed by Newton: "I am induced by many reasons to suspect that all the phenomena of nature may depend upon certain forces by which particles of bodies by some causes hitherto unknown are either naturally impelled towards each other and cohere in regular figures, or are repelled and recede from each other".

The formulation of the law of conservation of energy reflects, on the other hand, the change in the physical thought of the nineteenth century. Matter and mass were relegated to a secondary position by field and energy. Though the concept of energy helped to advance physics, the physicists were not at all sure what it really was. Whitehead, describing this state of affairs, says that "energy depends on the notion of an organism. The question is, can we define an organism without recurrence to the concept of matter . . . ?"

In the twentieth century, as a direct outcome of the relativity theory, mass and energy are found to be interconvertible. The two above-mentioned laws are combined into one conservation law of mass-energy; and the equivalence foreshadows the wave-particle equivalence in the electron. This contradiction in physics, that we have apparently two opposite concepts describing one of the fundamental units of the material world, can be understood as a contradiction between content and form. The particle side of the electron forms its material content, which has a wave-like form. This contradiction is dynamic and expresses itself in their interconversion. The same on a somewhat higher plane applies to the mass-energy interconversion. Modern physics has arrived at a point where Newton's postulate describing natural phenomena in terms of particles is still fulfilled: yet there is a great difference. Newton and his mechanical school could not explain qualitative changes. To-day we know that physical theory has to take account of the fact that, when things are summed, the process is not only quantitative, but also involves a qualitative change as well. A glance at the table of chemical elements will soon convince us.

Since mathematics proved to be a first-class tool by which natural phenomena can be understood, it is obvious that with the growing complexity of these phenomena the mathematical side is becoming more and more complex, hence more abstract, while through this quantitative treatment our knowledge of Nature is really becoming more and more concrete. This contradiction links up with yet another contradiction which exists between science and social organization. It is a paradox that while the scientific worker is more than anybody else responsible for the great advances of civilization, he is at the same time to a great extent divorced from the realities of everyday life.

This contradictory state in science and society forms the background to the efforts of powerful anti-social circles who would encourage the perversion of science into an instrument of destruction. There are scientific men who, perhaps genuinely trying to build for themselves a philosophical framework within which they can work, support these efforts unconsciously. Their books form a useful ally for those who have no interest in science as a progressive factor of social life. As Sir Charles Darwin says: "They excite the wonder of the reader by suggesting to him what extraordinary difficulties there are in the ideas of physics; they are like a conjurer whose tricks seem to us inexplicable". There are others, happily not a majority, who support such moves wholeheartedly. We have only to quote the Nazi-leader Rosenberg about one of these men of science to illustrate the point: "As a thinker Professor Lenard has taught all knowledge is not the same, but souls of alien races produce bodies of knowledge of different spiritual contents".

It is in connexion with these terrible distortions of science that we have to study Newton and his influence on scientific thought, so that this study is not solely of an academic nature. Newton's principles are perhaps best described by Randall, when he says that his most significant contribution lay in the fact that he proved that the ordinary physical laws which hold good on the surface of the earth are valid throughout the solar system. This positive content of Newton's teaching, his objectivism and rationalism, has been transmitted to us by Laplace and Lagrange, by Lavoisier and Dalton, by Planck and Einstein, and in fact has become one of the main features of general scientific thought. The gulf between Lenard and Newton is obvious.

It is in connexion with this gulf that we have to study Newton and his period. There the interdependence of science with the outside world is fairly straightforward. Science and productive forces were in their infancy and their mutual relationship comes out clearly. We can see from it that science has social roots, that the character of scientific progress depends upon social changes. If the main social forces at a definite period are such that men are conscious of their tasks and are striving to solve them, then science progresses too.

What is the task which faces the man of science in this struggle? The answer given by Bernal is: "The task which the scientists have undertaken—the understanding and control of Nature and of man himself—is merely the conscious expression of the task of human society." If we agree with him then we recognize in Newton a great fighter for this aim, and his rationalism and objectivism an essential weapon through the ages which it is our duty to guard.

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THEORIES OF TRICHROMATIC VISION

By PROF. H. HARTRIDGE, F.R.S.

THERE are frequent discussions concerning the rival hypotheses of colour vision, but seldom, if ever, do we see discussed the relative positions of the two rival theories of trichromatic vision. There are two possible plans which present different advantages. These are: (1) That each cone of the retina is able to respond to every one of the three kinds of sensation, red, green and blue; (2) that there are three entirely different kinds of cone, one for the sensation of red, one for the sensation of green, and one for the sensation of blue. The advantages and disadvantages of these two rival hypotheses will now be considered in turn.

The Single-Cone Hypothesis

According to this hypothesis, every cone of the retina is capable of responding to more than one colour sensation. In the fovea centralis every cone can give responses to three colour sensations. In the more peripheral parts of the retina, however, the responses of the cones may be somewhat curtailed to account for the diminution of the colour sense which is found there experimentally.

So far as is known, no single nerve fibre is capable of transmitting more than one kind of nerve impulse. Moreover, each cone of the retina connects with one fibre of the optic nerve and no more. In consequence, every cone must be capable of transmitting up its nerve fibre three different sensations, and this can only be done by variations either in frequency or in the pattern of the nerve impulses which are sent up to the brain. Suppose, for example, that when a cone responds to red rays it sends up its nerve fibre 100 impulses per second, whereas when responding to green it sends up 300 and for blue 1,000. Then, provided that the brain has the necessary structure for recognizing these three different frequencies, recognition of red, green or blue may be satisfactorily explained. When, however, two colour sensations are simultaneously being perceived, there would have to be a transmission of two separate frequencies to the brain. It does not seem easy to picture the simultaneous transmission of two such frequencies. But, on the other hand, alternative bursts of the two frequencies is not improbable; for example, suppose a cone were to be responding to red and green stimuli simultaneously, then a short burst of 100 nerve impulses per second would be followed by a short burst of 300 nerve impulses per second, and so on in alternation so long as the stimulus lasted. When white light is falling on the retina and, in consequence, according to the trichromatic theory, all three sensations are being aroused, there would have to be alternations of the three frequencies, each lasting for

a short period, and being followed in turn by the remainder.

Now since the type of colour sensation is determined by frequency, it is impossible for intensity of light to be transmitted by any variation in the number of nerve impulses per second sent up the particular nerve fibre. In consequence, it is a corollary of this hypothesis that each cone performs in an all-or-none manner, and that different cones have different thresholds, so that as the intensity of light increases the number of cones responding to that light increases; thus the active cone population will be small when light intensity is small and will increase to a maximum number as light intensity increases. Sooner or later, as this increase in light intensity continues, the whole of the cone population will have been brought into a state of activity, and further increase of light intensity which takes place will not cause a corresponding increase in the intensity of the sensation received by the brain.

The advantages and disadvantages of this theory may be stated as follows.

Since each cone responds to every colour, visual acuity with coloured light should be exactly equal to visual acuity with white light, and this fits in with experimental observation, any variations which are met with in practice being accounted for without difficulty, by variations in the sharpness of the image projected on the retina by the optical system of the eye. Since the number of active cones increases with the increase of light intensity, an explanation is given for the increase in visual acuity which is observed as light intensity increases. This theory also gives a reasonable explanation of the appreciation of variation of light intensity, since the small increase of light intensity is accompanied by an increase in the number of active cones. This theory gives no explanation of the important observations of Styles and Crawford, who found that the directional effect of the retina differed considerably in detail according as red rays, green rays or blue rays were used for the investigation. It would have been expected, on this theory, that the directional effect would have been the same for all colours, since the colours make use of identically the same cones.

The Triple-Cone Hypothesis

According to this hypothesis, every cone of the retina is capable of responding to one colour sensation only. Thus, in the fovea centralis, there must be three different types of cone, those responding to red, those to green, and those to blue. In the more peripheral parts of the retina, however, one of these types of cone, namely the green, may be reduced in number or may be omitted altogether in order to account for the diminution of the colour sense which is found there experimentally.

According to this hypothesis, the brain receives nerve impulses which inform it of the colours present in the image formed on the retina. It is possible that every one of these cones behaves in an all-or-none manner as was suggested by Hecht, but it is also possible that each of these cones responds in a graded manner, sending impulses along the optic nerves which vary in frequency according to the intensity of light which is falling on the cone in question. This view, which was suggested by me, has been supported experimentally by Hartline and others. This theory fits in admirably with the directional effects found by Styles and Crawford, namely that red light, green light and blue light each has a directional effect which differs from that of the others.

An apparent difficulty is met with in connexion with visual acuity which, at first sight, should have a markedly lower value for light of a single colour than is found for white light, since only about one third the number of cones is being stimulated. This difficulty is, however, avoided when it is remembered that in any random distribution of several different populations there are always places to be found where one population predominates over the others. An excellent example of this is the colour screen of the Lumière photographic plate. In this, there are distributed irregularly three different coloured groups of starch grains, red grains, green grains and blue grains. When such a screen is looked at with the naked eye, red, green and blue dots are clearly visible. On examining these dots with a microscope it is seen that they are not due to isolated starch grains but to quite large groups of grains of almost entirely one colour. Now if the cones of different colour response are distributed irregularly in the same way, then we should expect to find places where red cones predominate and other places where green cones are in excess, and other places again where blue cones are nearly exclusively present. In consequence, when high visual acuity is wanted for any one colour, it is possible to obtain it by causing the image of the object in question to fall on a part of the retina where the cones sensitive to that colour predominate. In the case of yellow light, a spot where there is a predominance of both red and green cones with the almost complete exclusion of blue cones would be most suitable for the purpose.

Evidence of Colour-Blindness

As is well known, colour-blind persons usually fall into one of four categories: (1) protonopes, who are red blind; (2) deuteronopes, who are green blind; and (3) tritonopes, who are blue blind; and (4) anomalous trichromats, who have abnormal colour vision which is, however, less severe than that of any of the three classes mentioned above. The first three types are readily explained on the triple cone hypothesis by supposing that the cone responsible for the missing sensation is either entirely absent or is defective, whereas anomalous vision is explained by a partial defect in one of the sets of cones, usually the green. In the case of the single-cone hypothesis, an explanation has to be sought for on the following lines: either there is deficient in the retina a chemical substance capable of absorbing light of the missing colour, or that the cones themselves are unable to respond to the catalytic products of this chemical substance when it has been broken down by the action of light. Of these two alternative explanations, the first seems to be the more plausible and the easier to picture, although it should be pointed out that there is no histological evidence for the deficiency of one particular type of cone in the retinas of colour-blind persons. In consequence, colour-blindness, which might have been expected to differentiate between these two theories and to eliminate one of them, in actual fact fails to do so.

Conclusions

We have seen that there are two rival mechanisms, both of which will provide trichromatic vision. Of these, the one which most closely fits in with the known facts is that which postulates three different varieties of cone, one corresponding to red light, another to green light, and a third to blue light.

OBITUARIES

Mr. James MacLehose, LL.D.

JAMES MACLEHOSE, chairman and managing director of Robert MacLehose and Co., Ltd., printers to the University of Glasgow, died at his home, 5 Heriot Row, Edinburgh, on December 14, 1943. He was born at Glasgow on April 9, 1857, the second son of that James MacLehose, publisher and bookseller to the University of Glasgow, whose name figures frequently in Mr. Charles Morgan's charming book, "The House of Macmillan".

James MacLehose was educated at the University of Glasgow, to which he proved a loyal son, and with which he was intimately associated both as bookseller and publisher for many years, and as printer for a longer period. From 1899 until 1909 he was vice-president of the board of management of the Students' Union. His services to scholarship fall under four heads: his eminence as a printer, his work as an author, his editorship, throughout twenty-five fruitful years, of the *Scottish Historical Review*, and his value as an active member of the board of trustees of the National Library of Scotland, the Advisory Committee on Scottish Records, the Scottish History Society and similar bodies.

He has himself stated that his "firm has endeavoured, not without some measure of success, to take its share in upholding the reputation of Scottish and also of British printing". This modest claim was fully substantiated by the elegance and accuracy of the work produced. He maintained the Foulis tradition in Glasgow. He was proud of the edition of "Hakluyt's Voyages" in twelve volumes, and of "Purchas his Pilgrimes" in twenty volumes, produced almost forty years ago, and, in recent years, of the great edition of Scott's Letters edited by Sir Herbert Grierson and published by Constable and Co. His press was identified with the production of volumes on higher mathematics and with the "development of colour printing and its use in educational and medical books". Its imprint has appeared on innumerable school and university text-books. Furthermore, he was the historian of his craft. His volume, "The Glasgow University Press, 1638–1931", was marked by painstaking research and an unflinching desire to arrive at the truth.

These qualities had been sharpened and burnished by his editorship of the *Scottish Historical Review* (October 1903–July 1928), his greatest contribution to the intellectual life of Scotland. When he retired from the editorship he was presented with an address by a representative committee. The following sentences are culled from that address prepared, it may now be revealed, by the late Sir George Macdonald: "To you and to you alone belongs the credit alike for its sterling character and for the regularity of its appearance. Inspired by a genuine interest in the past of your native country, you have given of your best to foster that interest in others, sparing neither time nor money in furtherance of the cause you have so deeply at heart, and bearing almost alone the burden of the whole undertaking." The address also referred to the *Review* as "that storehouse of knowledge of which you have been at once the architect and the warder".

As chairman of the Books and MSS. Committee of the board of trustees of the National Library, Mr. MacLehose, by voice, pen and personal persuasiveness, did much to arrest the destruction or dispersal of family papers of historical and literary value, and ensured their presentation to, or purchase by, the National Library. He was indefatigable. With every inducement to look back over a past packed with achievement, he was, even in old age, when his sight was dim and his natural force abated, ready to live in the present and work, passionately, for the future. "I must home to work while it is called day; for the night cometh when no man can work" might have been his motto, as it was Sir Walter's. The distinguished art of Sir James Guthrie has brought out, most successfully, this eager, forward-looking, vibrant quality in him.

Mr. MacLehose was capped LL.D. of the University of Glasgow in 1915. He was a fellow of the Society of Antiquaries, and of the kindred body in Scotland. He married Mary, daughter of Alexander Macmillan, and is survived by her and by a son and two married daughters. His elder son fell in action as an infantry officer in the War of 1914–18.

W. R. CUNNINGHAM.

Mr. F. S. Marvin

A HISTORIAN with a keen appreciation of the importance of scientific conceptions in the growth of society and a gift for clear exposition passed away in the person of Francis Sidney Marvin, who died on November 14 in his eighty-first year. Marvin was educated at Merchant Taylors' School and St. John's College, Oxford, obtaining a first in Greats and a second in modern history. After teaching for a time in an elementary school, he became one of H.M. Inspectors of Schools, remaining with the Board from 1890 until 1924 and reaching the grade of staff inspector. His chief interest was in history, and from 1915 onwards he organized many courses of lectures for teachers and others. For the session 1929–30 he occupied the chair of modern history in the University of Cairo. After his retirement he was mainly occupied in writing, and in the organization of branches of the Historical Association, to which he frequently lectured.

In August 1914 Marvin was taking part in a meeting of the London Adult School Union at Jordans when war broke out. Feeling that the conception of world history as a unity was sadly lacking, and that this lack had a part in the bringing about of wars, he planned the "Unity History Schools", which met annually, with few interruptions, until the outbreak of the present War. Until 1922 these were held at the Friends' Woodbrooke Settlement, but the 1923 meeting took place in Vienna, and several subsequent meetings were held in Continental cities. Marvin's planning and direction of these schools was admirable. He was most successful in enlisting experts as lecturers, in encouraging discussion, and in summing up the conclusions. A well-grounded classical scholar, he was devoted to the study of history as a continuing record of man's progress. His knowledge of history was wide, but he made no display of erudition, and his style was clear and simple. Although his training had not been in science, he was remarkably successful in seizing the main trends of scientific thought and discovery, which he followed closely, as was shown by his numerous reviews in NATURE of books on sociology and the history of science.

Two of the Unity History Schools dealt specifically with science: that of 1922, when the subject was "Science and Civilization", and that of 1935, when "Science in the Modern World" was discussed in

Rome in a joint meeting with the History of Science Department of the University of Rome. Most of the symposia were published, and some passed through several editions.

An active member of the small Positivist group, Marvin had adopted Comte's teaching that the ladder of the sciences must be completed by sociology. From Comte, too, he had drawn his conviction of Humanity as an ideal, and in recent years, amidst the apparent breakdown of civilization, he never lost his faith in the ultimate triumph of right over wrong.

Marvin's best-known book was "The Living Past", first published in 1913 and several times reprinted. As a comprehensive survey, in which the development of thought is presented as an essential part of history, this short work is perhaps unrivalled. At a dinner in honour of Marvin's seventieth birthday, at which Gilbert Murray, H. G. Wells and others spoke, tribute was paid to his stimulating influence on the study of history. His other books included "Comte" in the series of "Modern Sociologists", "The Century of Hope", "The New Vision of Man", and "The Nation at School". He took an active part in the work of the Sociological Society and its successor, the Institute of Sociology. He married in 1904 Edith May Beverell, and had two sons.

C. H. DESCH.

WE regret to announce the following deaths:

Dr. Walther Kruse, successively professor of hygiene at Bonn, Königsberg and Leipzig and discoverer of the Shiga-Kruse dysentery bacillus, aged seventy-nine.

Dr. F. L. Pyman, F.R.S., director of research, Boots Pure Drug Co., Ltd., on January 1, aged sixty-one.

Mr. Alfred Sidgwick, a distinguished philosopher and logician, on December 22, aged ninety-three.

NEWS and VIEWS

New Year Honours

THE New Year Honours include the names of a number of scientific workers and others associated with scientific work. The principal honours are as follow:

G.C.M.G.: Sir George Gater, Permanent Under-Secretary of State, Colonial Office.

C.H.: The Right Hon. R. S. Hudson, Minister of Agriculture and Fisheries.

K.C.V.O.: Sir Harold Hartley, chairman of the Fuel Research Board.

Knights: Prof. Ernest Barker, emeritus professor of political science in the University of Cambridge; Prof. J. C. Drummond, scientific adviser to the Ministry of Food, professor of biochemistry in the University of London; Prof. F. L. Engledow, professor of agriculture in the University of Cambridge; Dr. J. J. Fox, Government Chemist; Prof. F. R. Fraser, director-general of the Emergency Medical Services; Mr. W. T. Halcrow, engineering consultant, War Office; Mr. C. R. Lockhart, chairman of the East African Production and Supply Council; Mr. T. R. Merton, scientific adviser to the Ministry of Production, formerly professor of spectroscopy in the University of Oxford; Mr. J. G. Nicholson, deputy chairman, Imperial Chemical Industries, Ltd.

C.B.: Mr. P. N. Harvey, director of statistics and intelligence, Ministry of War Transport, Department of the Government Actuary; Mr. C. Nathan, principal assistant secretary, Ministry of Agriculture and Fisheries.

C.M.G.: Right Rev. Mgr. C. Gagnon, rector of Laval University, Quebec, for services to university education; Mr. E. B. Hosking, chief native commissioner, Kenya; Dr. R. C. Wallace, principal and vice-chancellor of Queen's University, Kingston, Ontario, for services to university education.

C.I.E.: Colonel R. H. Phillimore, superintendent of the Survey of India; Mr. M. Carbery, director of agriculture, Bengal; Sri Pattipati H. Rama Reddi, director of agriculture, Madras; Mr. D. B. Sothers, chief conservator of forests, Bombay.

C.B.E.: Mr. W. A. Akers, a director of research, Department of Scientific and Industrial Research; Prof. C. H. Best, professor of physiology in the University of Toronto, for important medical research; Major R. F. Brebner, chairman of directors, Highland and Agricultural Society; Dr. A. N. Drury, director of the Lister Institute, lately a member of the scientific staff of the Medical Research Council; Dr. W. H. Glanville, director of the Road Research Station, Department of Scientific and Industrial Research; Prof. D. A. L. Graham, professor of medicine and clinical medicine and dean of the Department of Medicine, University of Toronto, formerly president of the Royal College of Physicians and Surgeons of Canada, for important medical research; Dr. H. W. Meikle, H.M. historiographer in Scotland and librarian of the National Library in Scotland; Mr. W. Nairn, president of the Royal College of Veterinary Surgeons; J. M. Stewart, K.C., of Halifax, Nova Scotia, for services to university education and also as coal controller; C. Vaillancourt, of Levis, Quebec, for services to war finance and agriculture.

Royal Society Meeting in India

ON January 3, the Royal Society of London convened a short session at the University of Delhi prior to the opening of the Indian Science Congress by the Viceroy of India, Lord Wavell. This is the first time during the nearly three hundred years of its existence that the Royal Society has held a meeting outside London. Prof. A. V. Hill, who is visiting India in connexion with scientific aspects of the war effort, had been appointed vice-president for the occasion. Thus was he able to convey the greetings and goodwill of the President and Council of the Royal Society to the scientific workers of India. The King, who is Patron of the Royal Society, was represented by the Viceroy. There were Indian fellows of the Royal Society present and a large number of guests. Prof. Hill read greetings from the Prime Minister and General Smuts; also from other British scientific bodies. After his address, two recently elected Indian fellows of the Royal Society, Dr. H. J. Bhabha and Sir Shanti Bhatnagar, signed their obligation to the Society on a sheet of parchment which will be inserted in the Society's Charter Book.

British Cotton Industry Research Association: Sir Robert Pickard, F.R.S.

SIR ROBERT PICKARD has for so long been a figure in scientific and educational circles that his retirement, with the close of 1943, from the directorship of the British Cotton Industry Research Association marks something of an epoch. It is seventeen years since he was appointed to succeed the first director, Dr. Crossley, at the Shirley Institute, and all that time it has been his endeavour and pride to build it up until to-day it is the splendid organization that we know, with a staff of more than three hundred and fifty, including eighty graduates. The Cotton Research Association was Sir Robert's particular interest, the child that he brought to vigorous manhood, but he has been a champion of co-operative research associations in general, and it is a question whether any other man has done more for the movement. He was the first director of the British Leather Manufacturers' Research Association before he went to the Shirley, and he has served besides on the councils of two other research associations. It is good to learn that his retirement does not mean that his services to industrial research will be lost entirely, for, doubtless among other activities, he will still be retained as a consultant by both the Associations he has directed.

Sir Robert's connexion with education goes back years even before his research association days. He has been principal of Blackburn Technical School (1907–19) and principal of the Battersea Polytechnic (1920–27), and he has been a member of the Consultative Committee of the Board of Education, a member of the Senate of the University of London since 1926, and has held the office of vice-chancellor of the University of London. A distinguished chemist, he has also played his part in the councils of his chosen subject, having served as vice-president of the Chemical Society, and as president both of the Royal Institute of Chemistry and of the Society of Chemical Industry.

Dr. F. C. Toy

DR. F. C. TOY, who succeeds Sir Robert Pickard as director of the British Cotton Industry Research Association, has been deputy director since 1930, and it is a source of pleasure that he is thus enabled to continue and extend the work he has shared with his chief. Dr. Toy is a physicist, educated at Launceston College, Cornwall, and University College, London, of which he is a fellow. He is well known in Institute of Physics circles, being a member of the Board, the Institute's representative on the National Committee for Physics of the Royal Society, and also chairman of the Manchester and District Branch. He served in the War of 1914–18 as an officer in the Royal Engineers, mainly on sound ranging, afterwards becoming chief physicist to the British Photographic Research Association, where for ten years he was occupied in fundamental researches on the mechanism of the photographic process.

Dr. Toy firmly maintains this fundamental outlook acquired in his earlier days, and he enters upon his new duties with the conviction, based on the experience of the whole of his research life, that pure, long-range investigations constitute more than ever an essential part of the work of any co-operative research organization. This is heartening knowledge for those who recognize where lies the future welfare of British industry, and their good wishes go with the new director of the Shirley Institute as one who not only has helped to form its high scientific character but also is deeply concerned to uphold it.

Action of the Germans in the U.S.S.R.

ON behalf of the Soviet Scientists Antifascist Committee, V. Komarov, president of the Academy of Sciences of the U.S.S.R., A. Bogomolets, president of the Ukrainian Academy of Sciences, and several members of both academies, have sent a message to the Faraday Society, in the course of which they record some of the devastation which has been the regular accompaniment of the German retreat in the U.S.S.R. "Wherever the German army has been, it has brought death and slavery to the people, and destruction of culture." Prof. Nikolai Burdenko, of the Academy of Sciences, U.S.S.R., who personally investigated the crimes of the Germans in the city and district of Orel, refers to the state of psychological stupor of both victims of the German occupation and of medical men treating them. Referring to the material damage, it is stated that when they retreated from Smolensk, the Germans burned down the Teaching, Nutritional and Agricultural Institutes, destroyed the Finance, Co-operative, and Railway Technical Institutes, and the Institute of Telegraph and Telephone Communications, and looted valuable collections from Smolensk museums. In the town of Staline, they wrecked the Medical Institute and burned down all the buildings of the Industrial Institute where 15,000 students studied. In Kiev, a number of large buildings, among them the University, with its library, museums and laboratories, were destroyed. All the Kiev museums, libraries, archives, laboratories and research institutions were looted, according to Alexander Palladin, vice-president of the Ukrainian Academy of Sciences. Prof. Alexander Brodsky, of the Ukrainian Academy of Sciences, states that the Germans blew up and burned the Mining Institute, with its library, at the University Institute of Applied Chemistry, and looted and destroyed a number of other research institutes at Dnepropetrovsk. Prof. Peter Budnikov, of the Ukrainian Academy, who visited Kharkov, states that the Germans destroyed the Institutes of Applied Chemistry and of Electrotechnical Engineering, and other institutes.

The message was received at the annual general meeting of the Faraday Society, and by the authority of the Council, and at the wish of those members of the Society who were present, the following reply was sent: "The members of the Faraday Society have received your tragic message with horror and profound sympathy. The Society will do its utmost to bring it to the notice of all scientists and intellectuals of the United Nations to the end that civilization shall be protected and justice be meted out to the barbarians. E. K. RIDEAL (President), G. S. W. MARLOW (Secretary)."

Scientific Personnel in the Aircraft Industry

THE seventeenth report of the Select Committee on National Expenditure for the session 1942–43, containing replies from Government departments to recommendations in reports, includes a memorandum by the Ministry of Labour and National Service commenting on the Committee's recommendations in its tenth report, discussing aircraft production, on the supply of scientific and technical personnel. The memorandum states that the facilities available for

training research workers, aeronautical engineers and other technicians are under continuous review by the Technical Personnel Committee. It is agreed that men with postgraduate research and similar qualifications should not be allowed to enter the Forces, except for special commissioned posts, for example, operational research. The allocation and deferment arrangements of the Ministry of Labour are considered to provide ample safeguards for this purpose. A professional engineering or scientific qualification is, however, essential for many commissioned posts in the Fighting Services, and in view of the recommendations of Sir William Beveridge's Committee on the Use of Skilled Men in the Services, it has been recognized that a substantial proportion of technical officers in the Services in charge of maintenance and repair of equipment should possess technical qualifications of a university degree or professional standard together with extensive practical experience. But the numbers thus made available were insufficient. It has therefore been necessary to allocate a substantial proportion of the university output to the Services, and also to withdraw experienced men from industry; many of the latter have been volunteers, and the Ministry is concerned lest the Select Committee's observations should be misunderstood, with unfortunate effect on such volunteering.

Steps have also been taken to increase the supply of men graduating in technical subjects by means of the State bursaries, the intensive Higher National Certificate and the Engineering Cadetship schemes. Courses at universities have been shortened to a maximum of two years and three months (two years and nine months in Scotland), and by these measures the output has been substantially increased since 1941 and will reach a peak in 1944. In view of these shortened courses, the Technical Personnel Committee considers that specialized pre-graduate aeronautical courses could be extended only at the expense of fundamental engineering training. The needs of the industry during the War can best be met by the continuation of the existing pre-graduate engineering courses. Apart from a small number of the most promising men who can benefit by a special postgraduate course in aeronautics, graduates should proceed at once to aircraft establishments or firms where they can specialize and pull their weight at the earliest possible moment.

Health in Industry

A MAJOR problem brought to the fore during this War has been to bridge the gulf between scientific knowledge and its application. The Industrial Health Research Board has, during the last twenty-five years, published more than eighty reports on industrial conditions in relation to the health and well-being of the workers. Unfortunately, the necessity for publishing all the data, so that other workers in this field could know what exactly was the evidence on which the conclusions were based, rendered them of little use to those concerned with organizing industry. To remedy this, pamphlets are to be issued giving the conclusions in more general form, and No. 1, called "Ventilation and Heating; Lighting and Seeing", has just been published (H.M. Stationery Office, price 3*d*).

The first part deals with the need for ventilation, the amount of fresh air required, air movement and its problems, some effects of high temperatures, and the complications due to the black-out. The second part gives the principles of good factory lighting, how to measure light, and how the factory regulations should be interpreted, so as to ensure a good general appearance of cheerfulness as well as sufficient light to see the work. Good lighting alone cannot, however, prevent eye-strain for certain kinds of work, so there is a simple account of the working of the muscles of the eyes and of the relief to be secured by the use of special spectacles. There are illustrations showing different systems of artificial lighting, examples of undesirable as well as desirable systems. One undesirable method is called "Glare and Gloom". The pamphlet contains much useful scientific information expressed in readable form.

Measurements at Radio Frequencies

FOLLOWING the annual general meeting of the Radio Society of Great Britain held on December 18, Dr. R. L. Smith-Rose gave a lecture on "Measurements in Radio Experimental Work". After referring to the part played by amateur observers and experimenters in sciences such as astronomy and meteorology as well as in radio, Dr. Smith-Rose emphasized the importance of carrying out quantitative measurements in an orderly and systematic manner. A brief review then followed of the present position in the national laboratories of Great Britain and the United States, of the absolute electrical standards of current, inductance and resistance, and of the practical working standards which are derived therefrom. Frequency is one of the absolute electrical standards common to all branches of electrical engineering, from the low frequencies of the power engineer to the highest used in the modern applications of radio technique; and it is noteworthy that the precision of frequency measurement far exceeds that attainable in the determination of any other radio or electrical quality. With the possible exceptions of current and voltage, most measurements at radio frequencies, such as impedance, resistance and reactance, are made by reference to direct current or low-frequency standards. The lecture concluded with a brief description of some investigations illustrating the application of certain types of measurements at radio frequencies to the determination of the mode of transmission of electric waves along the earth's surface.

Determination of Polar Diagrams of Radio Antennæ

AN article by H. Paul Williams (*Elec. Comm.*, 21, No. 2; 1943) describes a machine which enables one to determine a polar diagram in a fraction of the time required by direct calculation. A computation which ordinarily would take a whole day can be performed in fifteen minutes on the machine. In its present version, it will calculate the polar diagram given by as many as five antennæ. These may be situated anywhere within a circle of four wavelengths diameter, while the currents in the antennæ may have any relative phases and magnitudes. The exploring angle is read off from a dial marked in degrees, and the corresponding relative amplitude is shown directly on a voltmeter. As few or as many readings as one likes can be taken, and also one may turn the handle backwards to a previous value if required.

With such a machine there is an appreciable reduction in the possibilities of errors—a feature quite as important as the saving of time. It is now also practicable to consider a large number of variations in a design the working out of which would take a prohibitive time without such a machine. Although

the number of antennæ catered for in the present model is five, the principle of operation will allow for its extension to any number. Moreover, the system could readily be extended for tracing out the polar curve automatically. For this refinement all that is required is a turn-table, which would be operated off the common main shaft, and a recording type voltmeter. The machine has been in constant service for about two years.

The Practice of Spraying

GROWMORE BULLETIN No. 9 ("Orchard Spraying for Commercial Growers". H.M. Stationery Office. Pp. 14. 4*d*. net) condenses a large amount of modern knowledge into useful practical suggestions for the spraying of fruit trees. Much of the text relates to the routine care of equipment in order to avoid replacement during war-time. Adjustment of the angle of spray cone to give good average coverage without wind loss conserves spray fluid and saves time. Modern research stresses the necessity for high-pressure spraying, and the corresponding variations in equipment and practice receive full treatment in the bulletin. Mr. J. Turnbull is the author, and much information about the economics of large-scale spraying is included.

Typhus in Venezuela

THE May issue of the *Boletin de la Oficina Sanitaria Panamericana* contains a note on this subject by Dr. L. Briceno-Iragorry, of the Laboratory of Epidemiology of the Venezuela Institute of Hygiene, who states that the first mention of typhus in Venezuela was in March 1896. Since then several cases have been reported in 1938, 1939, 1940 and 1941. The chief forms of the disease in Venezuela may be reduced to two, the first being named Guacaraja fever, which probably resembles Rocky Mountain spotted fever, and the second being known as benign, endemic or rat-borne typhus. The rat-borne character of this second form of typhus has been demonstrated by the Weil-Felix reaction in the blood serum of patients as well as in rats in the Caracas area.

Chronic Parasitoses in Bolivia

IN a recent paper (*Bol. Of. San. Panamericana*, **22**, 487; 1943) Dr. Felix Veintemillas, of the Bolivian Institute of Bacteriology at La Paz, states that no systematic study of chronic parasitoses, such as leishmaniasis, yaws, intestinal parasites, dysentery, Chagas's disease and pinto in the tropical and sub-tropical regions has so far been made, although some progress has been achieved. The Bolivian 'azulejos' has recently been identified with pintos, and the first case of granuloma coccidioides was diagnosed in 1941. So far, however, human cases of Chagas's disease have not been found, but infested vectors have been discovered.

Sir Henry Morris, Bart. (1844–1926)

SIR HENRY MORRIS, an eminent London anatomist and surgeon, was born at Petworth, Sussex, on January 7, 1844, the son of a local surgeon. He was educated at Epsom College, of which he afterwards became treasurer, University College, London, and Guy's Hospital, where he qualified in 1861. He first became attached to the Middlesex Hospital in 1870 as surgical registrar, and afterwards became assistant surgeon, then surgeon and in charge of the cancer wards. In 1871 he was lecturer to the Hospital on practical surgery, and during 1872–81 lecturer on anatomy. He retired in 1905 at the age of sixty. He was a prolific writer. His most important work was "The Anatomy of the Joints of Man", which was first published in 1879 and ran through eight editions. In 1893 he became editor of "A Treatise on Human Anatomy", to which he contributed the section on "The Articulations". This work also went through several editions. Besides numerous articles in medical journals and text-books, he was author of several works on genito-urinary surgery. He held many offices at the Royal College of Surgeons, of which the most important were president (1906–7), Hunterian Orator (1909) and member of the Court of Examiners (1894–1904). He died after a short illness on June 14, 1926.

Announcements

MR. R. W. MARSH, of the Long Ashton Research Station, has been elected president for 1944 of the British Mycological Society.

A SOVIET scientific commission is now in Novosibirsk, organizing a Western Siberian branch of the Academy of Sciences of the U.S.S.R. The Academy will establish four institutes in the city: for chemistry and metallurgy, mining and geology, medicine and biology, and transport and power.

EARL DE LA WARR, chairman of the Agricultural Research Council and director of home flax production at the Ministry of Supply, is making a tour in Canada to speak to audiences throughout the Dominion about the war-time agricultural effort in Great Britain; he will also visit various agricultural institutions in the Dominion, including research stations.

A LECTURE on a chemical engineering subject has been endowed by Mr. J. Arthur Reavell, and will be given under the auspices of the Institution of Chemical Engineers. It will be known as "The J. Arthur Reavell Lecture", and will be delivered not less frequently than once in every four years.

THE following appointments have been made in the Colonial Service: B. J. Hancock, agricultural officer, Gold Coast; D. A. McBurney, agricultural officer, Sierra Leone; C. C. Parisinos, agricultural officer, Northern Rhodesia; R. M. Palmer, assistant conservator of forests, Sierra Leone; J. R. G. Watters, assistant conservator of forests, Nigeria; A. L. C. Thorne, veterinary officer, Gold Coast; C. A. Cockshott, inspector of plants and produce, Gold Coast; J. H. Henderson, physiological laboratory superintendent, Nigeria; E. H. Probyn (assistant conservator of forests, Nigeria), assistant conservator of forests, Sierra Leone.

THE third conference on "X-Ray Analysis in Industry" has been provisionally arranged to take place in Oxford on March 31 and April 1 under the auspices of the X-Ray Analysis Group of the Institute of Physics. Particulars can be obtained from Dr. H. Lipson, honorary secretary of the Group, c/o Crystallographic Laboratory, Free School Lane, Cambridge. The conference will be open to all interested, but it may be necessary to limit the number of non-members of the Group for whom accommodation can be provided.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Recognition of a Further Common *Rh* Genotype in Man

SINCE the publication of a recent communication[1] on the subject of *Rh* genotypes certain advances have been made. The point had been reached, as described in that communication, where by the use of three different forms of anti-*Rh* sera, the genotypes of about 68 per cent of the population could be recognized, and five allelomorphs could be distinguished. Since then we have found a serum, described at a meeting of the Royal Society of Medicine on November 2, 1943, which, when used in combination with the other three, makes recognizable the genotype of about 80 per cent of people and defines two further allelomorphs, making seven in all. More recently a letter (see below) has come from Wiener describing all these allelomorphs except Rh_y. We will use Wiener's names, which are Rh_1, Rh_2, *rh*, *Rh′* (*rh* dot), Rh^o (Rh_3), but for the gene Wiener calls *Rh* (Rh_1 bar) we prefer Rh_o, for *Rh* has for so long had a much wider meaning. The names we have used[1] and are now abandoning are given in brackets. Rh_y we will continue to use.

The new serum agglutinates the red cells of people who have the frequent gene Rh_1 or the rare gene *Rh′*. It is undoubtedly the type of serum called by Wiener[2] anti-Rh_1. Perhaps its greatest use is in separating the genotypes Rh_1Rh_2 (12 per cent), Rh_1Rh^o (1 per cent) and Rh_2Rh' (0·2 per cent) from the serologically indistinguishable group called "the rest" in our previous communication. "The rest" group now contains only Rh_2rh (12 per cent) and Rh_2Rh_2 (2 per cent) of common genotypes while, ignoring the rare ones, the genotypes of about 80 per cent of people can be recognized.

We were first made aware of the existence of the forms Rh_o and *Rh′* when the blood of 154 unselected donors was tested with *Rh St KJ* and anti-Rh_1 sera. Of these, 57 gave the reaction of Rh_1rh (++−), all of them being positive with the new anti-Rh_1 serum except one. The presumption that the factor responsible for this unexpected reaction, now called Rh_o, is allelomorphic is supported by its occurrence in two generations of a family (father *rhrh*, mother Rh_orh, daughter Rh_orh). Rh_orh cells give the double dose effect[1] when titrated with *St* serum, showing that Rh_o is *St*+. Twenty of the 154 bloods gave the reaction of *rhrh* (−+−); of these all were negative with the anti-Rh_1 serum except one; the gene responsible for the exception is now called *Rh′*. In one family (No. 15, Race *et al.*[3]) this allelomorph has been found in two generations (mother's sister *Rh′rh*, mother *Rh′rh*, father Rh_1rh, first child Rh_1rh, fourth child *Rh′rh*). *Rh′rh* cells give the single dose effect when titrated with *St* serum, showing that *Rh′* is *St*−.

The total number of unselected bloods examined with *Rh*, *St* and *KJ* is now 435, and the last 154 of these have also been tested with the anti-Rh_1 serum. This latter serum is supporting the general theory put forward in the previous communication, for in the group *Rh*+*St*+*KJ*+ called "the rest", it can be calculated that 47 per cent should have either the gene Rh_1 or *Rh′*. In the 154 bloods there were 48++, and of these 20, or 42 per cent, were positive with the anti-Rh_1 serum ($\chi^2 = 0{\cdot}49$ for 1 *D.F.* Probability about 0·5).

The results with the three sera are:

	−+−	+−−	++−	−++
Mainly	*rhrh* (96%*)	Rh_1Rh_1 (96%)	Rh_1rh (97%)	Rh^orh (97%)
	75	75	149	4
Per cent	17·24	17·24	34·25	0·92

	+−+	−−−	+++	
Mainly	Rh_1Rh_2 (100%)	*Rh′Rh′* (100%)	The rest	Total
	3	0	129	435
Per cent	0·69	0	29·66	

* The figure in brackets shows, in the first case for example, the percentage of bloods reacting −+− which are in fact *rhrh*; the remaining 4 per cent are *Rh′rh*.

The gene frequencies given in the previous communication need slight alteration. Before calculating the frequency of *rh*, a deduction must be made from the 17·24 per cent −+− bloods, since one person in 154, or 0·65 per cent, previously thought to be *rhrh*, is now known to be *Rh′rh*. The gene frequency of *rh* is $\sqrt{0{\cdot}1724 - 0{\cdot}0065} = 0{\cdot}4073$; $Rh'rh = 0{\cdot}0065$; therefore $Rh' = \dfrac{0{\cdot}0065}{2 \times 0{\cdot}4073} = 0{\cdot}0080$. The frequency of Rh_1 can be calculated from the +−− group, of which Rh_1Rh_1 makes up 96 per cent, the remaining 4 per cent consisting of Rh_1Rh' (see Table 2), consequently:

$(Rh_1)^2 + 2(Rh_1Rh') = 0{\cdot}1724$, and since $Rh' = 0{\cdot}0080$, then $Rh_1 = 0{\cdot}4073$, by chance the same as *rh*. $Rh_1Rh_y = 0{\cdot}0069$.

$$\therefore\ Rh_y = \frac{0{\cdot}0069}{2 \times 0{\cdot}4073} = 0{\cdot}0085;\quad Rh^orh = 0{\cdot}0092$$

$$\therefore\ Rh^o = \frac{0{\cdot}0092}{2 \times 0{\cdot}4073} = 0{\cdot}0113;\quad Rh_orh = 0{\cdot}0065$$

$$\therefore\ Rh_o = \frac{0{\cdot}0065}{2 \times 0{\cdot}4073} = 0{\cdot}0080,$$

and by difference $Rh_2 = 0{\cdot}1496$.

Based on these gene frequencies, the expectation for the group ++− and for the group called "the rest" can be calculated, and the theory tested by comparison with observation.

	++−	"The rest"
Expected	34·50%	28·63%
Observed	34·25%	29·66%

The frequency of the commonest six genotypes as calculated from our sample are given below. These frequencies are only approximate for the community as a whole, the proportion of *Rh* negative being slightly higher than we have found in a much larger sample.

TABLE 1.

	Per cent	*Rh*	*St*	*KJ*	Rh_1
rhrh	16·59	−	+	−	−
Rh_1Rh_1	16·59	+	−	−	+
Rh_1Rh_2	12·19	+	+	+	+
Rh_1rh	33·18	+	+	−	+
Rh_orh	12·19	+	+	+	−
Rh_2Rh_2	2·24				

These total 93 per cent; the remaining 22 rarer genotypes make up 7 per cent, and ignoring these we are able to distinguish serologically between all the 93 per cent, except that we cannot make the distinction between Rh_orh and Rh_2Rh_2. Examination of thirty families has so far revealed no exception to this scheme of allelomorphs.

This was the state of our work when a letter, dated October 11, 1943, came from Wiener enclosing the typescript of a paper then in the press, in which is described the behaviour of six allelomorphs of the *Rh* gene. In Table 2 is a comparison of Wiener's scheme and our own:

Table 2.

Genes	Rh	Wiener Antisera (St)	Rh_2	Rh_1	Rh′	Rh″
Rh_1	+	0	—	+	+	+
Rh_2	+	0	+	—	+	+
Rh_3	+	0	—	—	+	+
Rh′	—	0	—	+	+	—
Rh″	—	0	+	—	—	+
rh	—	0	—	—	—	—

Genes	Rh	Race, et al. Antisera St	KJ	Rh_1
Rh_1	+	—	—	+
Rh_2	+	+	+	—
Rh_3	+	+	—	—
Rh′	—	—	—	+
Rh″	—	+	+	—
rh	—	+	—	—
Rh_y	?	—	+	?

The two schemes show complete agreement, save that Wiener has not met the Rh_y allelomorph because he has not had an *St* serum. The results are so strikingly similar that the probability of their being correct must be very high. We were stimulated by Wiener's letter to attempt to identify his types of sera with those we have used, and have found all of them represented in our collection. Among sera which have occasionally given anomalous reactions, we have been able to identify anti-*Rh′* and anti-*Rh″*. That we had not employed these two types of serum regularly does not seem to matter since the distinctions they make are already made by anti-*Rh*, *St*, *KJ* and anti-Rh_1. The great value of *St* serum is made clear, for ignoring those that are very rare, it raises the proportion of people whose genotypes are recognizable from approximately 30 to 80 per cent. While these schemes cover the great majority of our findings occasional anomalous results suggest that other very rare forms may exist.

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Dec. 1.

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Phenogenetic Evidence for the Amphidiploid Origin of New World Cottons

THE genus Gossypium may be divided cytologically into four main groups:

(1) Asiatic diploids .. .. .. ($n = 13$)
(2) American diploids .. .. .. ($n = 13$)
(3) Australian diploids .. .. .. ($n = 13$)
(4) New World 'tetraploids' .. .. ($n = 26$)

Cytological evidence[1,2] suggests strongly that New World cottons have been evolved by amphidiploidy from hybrids between Asiatic and American diploid cottons. It is supported by artificial syntheses of amphidiploids which produce partly fertile hybrids when crossed with New World types[2,3]. Phenogenetic evidence leading to the same conclusion is presented here.

It is known that Asiatic and New World cottons each have a series of multiple alleles which control the shape of the leaf. That a similar series occurs in American diploid cottons is highly probable, though critical data are not yet available. If New World cottons are amphidiploids of Asiatic × American diploid parentage they should have (at least initially) *two* leaf-shape loci, one homologous with the Asiatic alleles, the other homologous with the corresponding series in American diploids. Phenogenetic studies of the action of the leaf-shape alleles on the development of the leaf led to the suggestion[4] that the joint action of an entire (unlobed) leaf gene from the

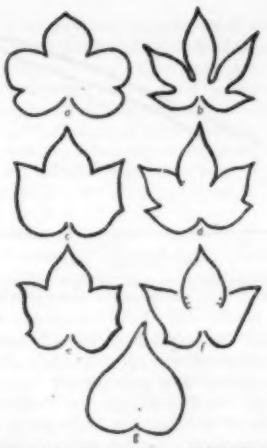

FIG. 1. TOP ROW: ASIATIC PARENTS, (*a*) *l* (*herbaceum*), (*b*) L^A (*arboreum*); SECOND ROW: ASIATIC × AMERICAN F_1s, (*c*) *l* × *raimondii*, (*d*) L^A × *raimondii*; THIRD ROW: NEW WORLD AMPHIDIPLOIDS, (*e*) *l* (*hirsutum* VAR. *latifense*); (*f*) L^B (*barbadense* VAR. *darwinii*); BELOW: AMERICAN PARENT, (*g*) *raimondii*.

American diploid parent and a lobed leaf allele from the Asiatic parent might reproduce a type of leaf development which is characteristic of New World cottons. In other words, the New World allelomorph series might be regarded as a series of Asiatic alleles acting in conjunction with an entire leaf gene at the other locus. No duplicate leaf-shape genes are known in New World cottons, so it was postulated, on this hypothesis, that the entire leaf gene is quite stable and common to all New World cottons.

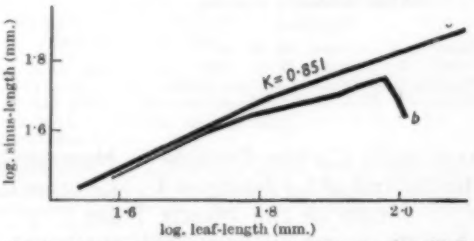

FIG. 2. DEVELOPMENTAL TRACKS OF ASIATIC × *raimondii* F_1 HYBRIDS: (*a*) *l* × *raimondii*, (*b*) L^A × *raimondii*.

Crosses between Asiatic and American diploid cottons very rarely set viable seeds (less than 0·5 per cent in my experience). However, two hybrids have so far been obtained:

	Asiatic		American
(1)	*G. arboreum* (L^A)	×	*G. raimondii*
(2)	*G. herbaceum* (*l*)		

The symbols refer to the leaf shape alleles carried by the Asiatic parents. The American species has entire leaves. Leaf outlines of the parents and hybrids are compared with standard New World types in Fig. 1. It can be seen that the leaves of F_1, L^A × *raimondii*, and F_1, *l* × *raimondii*, show a marked resemblance to the New World L^B and *l* leaf types, respectively. This resemblance is not a chance superficial one since the course of development is remarkably similar. Developmental tracks* of the F_1 compounds closely resemble those of the corresponding New World types (Figs. 2 and 3). The corresponding *l* × *raimondii* (Fig. 2) and *l* (Fig. 3) tracks are almost linear and

* Graphical representations[4] of the progressive change in leaf shape from node to node during the juvenile stages.

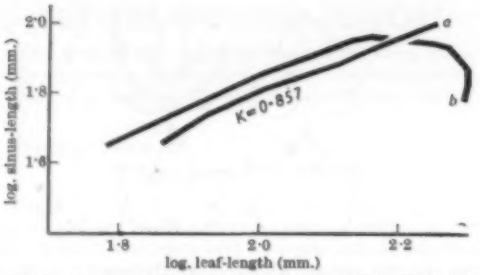

Fig. 3. DEVELOPMENTAL TRACKS OF NEW WORLD AMPHIDIPLOID TYPES: (*a*) *l*, (*b*) L^B. COMPARE WITH SYNTHESIZED TYPES IN FIG. 2.

can therefore be expressed as allometric developmental constants (K values). As shown in the figures, the two K values are practically identical.

Subject to confirmation by orthodox genetic analysis—which awaits the successful synthesis by colchicine treatment of a set of amphidiploids which will cross with New World types—the data suggest that two alleles of the New World series, L^B and l, are identical with $L^A + X$, $l + X$ respectively, where X is an entire leaf allele from an American diploid entire leaved ancestor. Four American diploid species with entire leaves still exist: *G. aridum*, *G. armourianum*, *G. klotzschianum* (including *davidsonii*) and *G. raimondii*. General morphological considerations suggest that either of the two last-named in combination with *G. arboreum* would produce a hybrid showing considerable similarity to present-day New World cottons.

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Acid-labile Carbon Dioxide in Mammalian Muscle and the Hydrogen Ion Concentration of the Muscle Fibre

FOR the isolated sartorius muscle of the frog it was found[1] that over a wide range of concentration of external potassium and chlorine ions the following relation applied (in accordance with the Donnan principle):

$$\frac{[K]_i}{[K]} = \frac{[Cl]}{[Cl]_i},$$

where $[K]_i$,$[K]$ are the potassium concentrations within and without the fibre, and similarly for [Cl]. It may be assumed that the following would likewise apply:

$$\frac{[K]_i}{[K]} = \frac{[H]_i}{[H]} = \frac{[Cl]}{[Cl]_i} = \frac{[HCO_3]}{[HCO_3]_i}$$

since H is a smaller cation than K, and HCO_3 about the same size as Cl.

Recently Wallace and Hastings[2] published data for the total carbon dioxide in mammalian muscle, finding therein about 11 mM. carbon dioxide per kilo—and allowing the free carbon dioxide to be in approximately equal concentration across the membrane, and the remainder to be altogether HCO_3 ion, it follows that the ratio $\frac{[HCO_3]_i}{[HCO_3]}$ would then be far higher than $\frac{[K]}{[K]_i}$. Therefore, either the mammalian muscle fibre has a much different electrolyte distribution and a different membrane permeability than frog muscle, or the fraction of the total carbon dioxide assigned by Wallace and Hastings to the HCO_3 ions is much too high.

The latter is the true explanation, as shown in recent work in this laboratory. The total carbon dioxide in mammalian muscle was determined by extraction in alkali solution and subsequent measurement of the carbon dioxide liberated on acidification. The figure of Wallace and Hastings was confirmed. It was found, however, that if to the alkaline extract saturated barium chloride was added, and the mixture centrifuged for about 90 minutes at 3,000 rev./min., in many cases a clear solution was obtained, and this contained more than half the total acid-labile carbon dioxide. The leg muscles of very young rabbits, and the abdominal muscle in general, were found to be the most satisfactory for the purpose.

For rabbit abdominal muscle the total carbon dioxide was found to be 11·4 mM. per kilo and the barium-soluble fraction 5·2. For the leg muscle of rabbit and cat the total was found to be 10·6 and the barium-soluble fraction 7·0 mM. per kilo. The reality of a true barium-soluble fraction of such magnitude was proved by the following facts. (*a*) Additions of HCO_3 (as potassium bicarbonate) to the alkali extracts before addition of barium chloride were fully precipitated. (*b*) A curve of turbidity against HCO_3 present before addition of barium chloride was obtained by first evacuating abdominal muscle for hours in the cold, and then extracting with alkali, and adding graded amounts of HCO_3 to similar volumes of extract. The turbidity on adding the barium chloride was measured in the Pulfrich turbidimeter, and expressed in absolute numbers. A value of 0·10 in the extract would about correspond to the barium-soluble carbon dioxide in extract of fresh muscle, whereas either no opacity was present after the barium chloride addition and centrifuging (90 min.) or so little that the total average value was 0·008, or only 8 per cent of the turbidity for the equivalent amount of HCO_3.

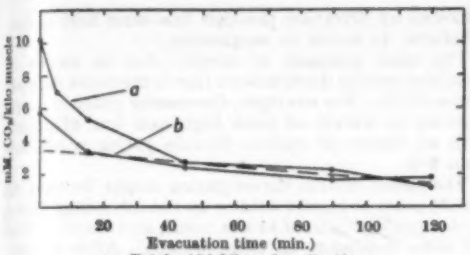
Nature of the barium-soluble fraction. From the researches of Henriques[3], Faurholt[4], Meldrum and Roughton[5], it might be expected that some at least of this barium-soluble fraction is carbamino carbon dioxide. We have investigated the time curve of carbon dioxide loss from evacuated guinea pig muscle, and obtained the mean curves as shown in the accompanying figure. It will appear that a 2–3 mM. fraction only of the barium-soluble quantity is given off rapidly, and the greater fraction, 3–4 mM. per kilo, is emitted very slowly. Only 2–3 mM. can therefore be regarded as likely to be carbamino carbon dioxide, the remainder being a still unknown compound.

The pH in the muscle fibre. The free carbon dioxide plus the HCO_3 ion in leg muscle is 10·6 — 7·0 = 3·6, and allowing for the interspace values, etc., the true value of the bicarbonate content in the water of the muscle fibre becomes 0·9 mM. per litre, whereas the carbon dioxide in the extracellular water is approximately 1·2 mM. per kilo. Therefore the pH is given by

$$p\text{H} = 6{\cdot}1 - \log 1{\cdot}2/0{\cdot}9 = 6{\cdot}0.$$

If, on the other hand, we consider the ratio

$$\frac{[K]_i}{[K]} = \frac{[H]_i}{[H]},$$



a. Total acid-labile carbon dioxide.
b. Barium-soluble fraction.

and that [K] = 5·5, and $[K]_1$ = 157, then since the [H] of serum is $10^{-7.42}$, we obtain in turn that the value of $[H]_1$ is $10^{-6.9}$, or the *p*H = 6·0.

In another communication Wallace and Lowry have brought evidence, as they believe, for the non-diffusibility of HCO_3 ion across the muscle membrane. Such experiments are readily interpreted both from the principles outlined for electrolyte equilibria across the muscle fibre membrane and discussed at some length in the *Journal of Physiology* of 1941[6], and the findings here described.

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Nitrogenous Manuring of Black Cotton Soil

RAIN-FED cotton is the principal money crop of the black soil tracts of India[1], which are often characterized by low yields and where nitrogen alone, among the three fertilizer elements nitrogen, phosphorus and potassium, has been found to be essential for increasing the yield[2]. Groundnut cake, ammonium sulphate and farmyard manure or compost have all given significant response, the expected increases in yield in pounds of seed cotton per acre for unit dose of nitrogen being 3·79 ± 0·22, 2·24 ± 0·17 and 1·19 ± 0·17 respectively.

Humic manures are slow-acting and do not, in consequence, compare favourably with other nitrogenous manures and fertilizers, at any rate in their immediate effect[3]. But the regular superiority of groundnut cake over ammonium sulphate, even on the immediate crop and, in spite of its slight but significant adverse effect on germination[4], was rather unexpected and warranted further examination. It has since been ascertained that application of groundnut cake and ammonium sulphate to the black, alkaline soil is followed by a certain amount of loss of ammonia, this loss being much more pronounced with ammonium sulphate than with the oilcake. It has been possible to measure, from time to time, the loss of gaseous ammonia *in situ* in field plots by a modification of the technique worked out by Subrahmanyan[5]. Thus, in plots treated with ammonium sulphate and oilcake at 80 lb. nitrogen per acre, the average loss of ammonia from random spots, over a period of 52 days, amounted to 35 and 19 mgm. respectively, the corresponding loss from untreated plots being 12 mgm. In similar experiments carried out in the laboratory, from 12·6 to 24·2 per cent of added nitrogen as ammonium sulphate could be accounted for through loss as gaseous ammonia during a period of a month, whereas, with groundnut cake, under identical conditions, the loss of ammonia ranged only from 8·1 to 16·5 per cent of the added nitrogen.

It would follow, therefore, that a given rate of application of ammonium sulphate would be less effective than its equivalent, on nitrogen basis, of groundnut cake by the extent of its increased loss of nitrogen as ammonia. An observation of interest was that loss of ammonia was considerably less where the ammonium sulphate or oilcake was drilled in furrows instead of being broadcast as is usually the case; such drilling or application at lower depths below the surface was also followed by higher increases in yield[6,7].

Loss of nitrogen from the soil through volatilization as ammonia has been noticed earlier[8,9] and would appear to be a general phenomenon with all tropical soils; indeed, under certain conditions, most of the nitrogen added as ammonium sulphate may be lost in this form within a fortnight[10]. The high alkalinity (*p*H frequently greater than 9·0) and lime status (replaceable calcium about 40 M.E.) of the black soil would doubtless favour heavy losses of ammonia from this soil, especially with high concentrations of added ammoniacal fertilizers. For this soil, therefore, it is possible that calcium nitrate may prove superior to ammonium sulphate, as has been found to be the case in the Sudan[7].

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Institute of Plant Industry,
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Nature of the Acid in Soft Water in Relation to the Growth of Brown Trout

As the owner of freshwater fishings in the north of Scotland, I am interested in the growth of brown trout. After making a *p*H survey of the waters in this area, it soon became evident that this *p*H reading was of very little use without knowing the factors which determined it, in Nature. Not wishing to be guilty of over-simplification or generalization, I would make it clear that these notes only refer to the natural acid waters as they occur here.

These waters are remarkable for the small quantity of minerals in solution, in many cases not exceeding 2 parts per 100,000. They normally consist of carbonates and bicarbonates of the calcium-magnesium group. I shall refer to this as the calcium content, which is the first of the two controlling factors.

The second is the amount of carbon dioxide in solution. A neutral water, *p*H 7, under the limitations

above, exists when the calcium content balances the carbon dioxide in solution. An acid or soft water is one in which carbon dioxide is in excess, and conversely a hard or alkaline water has an excess calcium content.

It will be objected that no mention is made of any other acid, mineral or organic. I maintain that there is no proof that any such acid exists in these waters. The generic term 'humic' acid is just a cloak for our ignorance. A. C. Gardiner, I understand, thought that there was a group of such acids, but that they could not be analysed and that they were too weak to effect ionization and consequently did not alter the *p*H. I can find no proof of this view—in fact, many analyses done for me by him appear to contradict it. In any event, if these hypothetical acids are so weak that we cannot detect them, I hold that we may neglect them as not having any possible effect on the ecology of the trout or its food.

During recent investigations (1939–42) a series of tests have been made on the following lines: (*a*) The *p*H of the sample was determined by the colorimetric test and checked by the electrical method. (*b*) Carbonate stability* was ascertained by adding a small quantity of finely powdered chalk to a part of the sample. (*c*) Air free from carbon dioxide was blown through the sample, thus removing the carbon dioxide in solution. (*d*) The *p*H was taken after removal of carbon dioxide. (*e*) The alkalinity of the water, after carbon dioxide had been removed, was determined and reckoned as parts of calcium carbonate per 100,000.

It should be noted that in every case carbonate stability was higher than the alkalinity, and that in no case was any carbonate taken up after the carbon dioxide had been removed. The *p*H was invariably greater than 7 after carbon dioxide had been removed. These facts would appear to indicate that carbon dioxide and not an organic acid is responsible for the initial low *p*H. This conclusion can only be negatived by assuming that the organic acid is too weak to affect the *p*H or to dissolve the powdered calcium carbonate—for which assumption there is no proof; nor if there were, would it be likely to affect the point at issue, namely, the growth of trout. The following table gives a few typical examples, including one of relatively high calcium content.

Sample	Initial *p*H	After CO_2-removal (*p*H)	Alkalinity	Carbonate stability	Uptake of carbonate after CO_2-removal
A	6·0	not read	2·0	3·4	Nil
B	6·2	7·2	2·2	2·6	"
C	6·2	7·4	2·7	3·4	"
D	6·0	7·1	1·3	1·8	"
E	6·6	7·6	10·8	14·1	"

One of the most frequent causes of acidity is sphagnum moss. If a quantity of this moss is introduced into a neutral or slightly alkaline water, it rapidly produces an acid reaction. This experiment may be repeated a number of times by squeezing the moss nearly dry by hand and adding it to fresh alkaline water, which is in turn made acid. If my theory is correct, this acidity is produced by carbon dioxide.

Another frequent characteristic of these acid waters is a brown peaty colour, although this is by no means always so. This colour may be largely removed by filtration through fine sand and is due, I believe, to solids in suspension.

The mere presence of acidity due to excess of dissolved carbon dioxide is no bar to the more delicate forms of life. For example, *Gammarus pulex* is found thriving in waters of both high and low alkalinity with an excess of carbon dioxide giving a *p*H less than 6·6.

The result of this investigation might be that we should cease to regard acidity as the inhibiting factor in the quick growth of brown trout, and search rather for some deficiency in these waters. After investigating the question as regards iodine and phosphorus, A. C. Gardiner came to no definite conclusion, and to conclude I would like to quote him[1], whose mastermind we so sadly miss. "The basic question is, why are the trout in these waters so small? I am all too conscious that there is nothing very helpful in this article, but it may perhaps start a train of thought which, after the war, will result in the launching of an experiment specifically aimed at finding out why."

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* Carbonate stability is the maximum weight of carbonates, reckoned as parts of calcium carbonate per 100,000, which the water will hold in solution. It is the final alkalinity of the water determined after adding finely powdered chalk.

Detection of the K_α Satellites on X-Ray Powder Photographs

IN the course of recent research on iron-silicon ferritic alloys, a very faint extra line appeared on X-ray powder photographs taken with iron or chromium radiations. The line appeared close to a strong reflexion of high order. The assumption that it was due to an extra phase was eliminated by the fact that the line still appeared when pure elements were used as specimens.

It was then suggested by Dr. H. Lipson that this line could be due to the 'non-diagram' X-ray emission[1], and this has proved to be a satisfactory explanation. To support it, a photograph of carbonyl iron taken in a 19 cm. diameter camera with chromium radiation ($\lambda_{K\alpha_1} = 2{\cdot}28500$ kX. and $\lambda_{K\alpha_2} = 2{\cdot}28889$ kX.) was measured and the wave-length corresponding to the extra-line appearing with the 211 doublet was found to be 2·2736 kX. This is in good agreement with the values published by Parratt[2], who made an

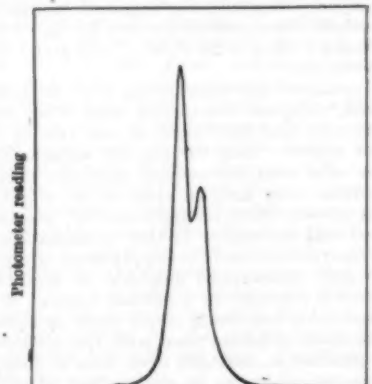

Fig. 1. Photometer curve of line 211 carbonyl iron (chromium $K\alpha$ radiation).

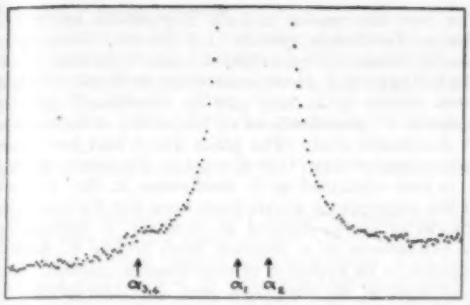

Fig. 2. Experimental points from which Fig. 1 is derived.

extensive study of the $K\alpha$ satellite lines by means of a double spectrometer and an ionization chamber. He found four components for the $K\alpha_3\alpha_4$ group, the two principal ones for chromium having the following wave-lengths: $K\alpha_3 = 2{\cdot}27443$ kX.; $K\alpha_4 = 2{\cdot}27290$ kX. The photometry of the 211 lines confirms the presence of this extra reflexion, as shown by Figs. 1 and 2.

We have detected also the $K\alpha_3\alpha_4$ group with nickel, cobalt and iron radiations, using specimens of pure elements which give a strong high-angle reflexion. The line was weaker with the shorter wave-lengths, in agreement with Parratt's data[2].

To the best of our knowledge, this is the first time that the $K\alpha_3\alpha_4$ group has been definitely detected on powder photographs. The possibility of the appearance of this reflexion, the intensity of which is about 1/100 of the intensity of $K\alpha_1$, should be borne in mind when strong high-angles lines occur on X-ray photographs.

We wish to thank the Director-General of Scientific Research and Development, Ministry of Supply, for permission to publish this note.

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Cambridge. Dec. 11.

[1] Siegbahn, "Spektroscopie der Röntgenstrahlen" (Julius Springer, 1931). Compton and Allison, "X-Rays in Theory and Experiment" (D. van Nostrand Co., Inc., 1935).
[2] Parratt, *Phys. Rev.*, **50**, 1 (1936).

Post-War University Education

WHILE possible changes in university education after the War are being considered, I should like to urge the importance of one problem which has hitherto obtained little prominence. Anyone who had much contact with students before the War could not fail to be impressed by the specialized nature of most of their knowledge. For example, a graduate in classics was often completely ignorant of scientific thought, while a graduate in any of the sciences, as a rule, knew little of humanistic subjects beyond some French and German. Moreover, there is little doubt that this increasing departmentalization of the universities was encouraging the tendency, so disastrous at the present time, whereby what is scientific is divorced from humanistic purposes. The regulation at some universities compelling an honours student to take one or two classes outside his honours group, while good in theory, fails in practice, because these other classes are much too narrow in their aims and are, in fact, often the first-year courses for students who propose taking honours in them.

How can this be remedied? It would be a retrograde step to decrease the specialization of the honours groups, and the proposal of the British Association Committee on Post-War University Education to introduce a new honours group, called "philosophy, natural and social", does not solve the present difficulty, namely, how students, in honours groups which already exist, can acquire a more balanced and mature mental outlook.

The best solution, it seems to me, is the introduction of a course dealing with what is called in the United States "The History of Ideas". Such a course would deal with the growth and development of conceptions which play a great part in our intellectual life to-day—conceptions such as individual freedom, social equality, scientific law, moral obligation, evolution, the nature of scientific method, and so on. At universities where attendance at lectures is, to some extent, compulsory, I should like to see such a course compulsory for all honours students in the year before they sit for their final examination. They would at this stage be more mature than freshmen and yet not be under the strain of working for their degree examination. At universities where attendance at lectures is entirely voluntary, I should like to see those students who did not attend the course compelled to take the examination in it, so that they would at least have been forced to read books like Whitehead's "Science and the Modern World" and Coulton's "Medieval Panorama", and to discuss some of the problems raised by them under the guidance of a tutor. I am urging this step for honours students only. Undergraduates who are reading for a pass degree are at present able to study a considerably wider range of subjects, and the problem is therefore not so pressing for them. Besides, it is most necessary that those who are intellectually the most able should have this broad background against which they can set their own specialized activity.

If the desirability or, as I should prefer, the necessity of such a course is admitted, it would not be difficult to organize it. The best means, I think, would be for it to be given in university departments of education. At present such departments give courses on the history of education, and while these cover to some extent the rather dry topics dealt with by text-books appearing under that title, they deal mainly (or should deal mainly) precisely with the history of those ideas which have had a great influence on the development or education of mankind. It would no doubt mean that the departments concerned would have to make some domestic alterations, but it does not seem that any fundamental changes would be necessary.

It may be objected that the numbers for such a course would be much too large. If that is so, it might be necessary for a few years to limit the number taking it until a large enough staff could be obtained to deal with them. But that is certainly not a permanent objection. I understand, although I have no direct knowledge, that a few years ago it was made compulsory for all Harvard undergraduates to take a course in American history. It seems to me the time is now ripe for all British undergraduates, of sufficiently high intellectual capabilities, to learn the history, not of this or of some other nation, but of what is common to all nations—the ideas which are the basis of the modern world.

C. D. HARDIE.

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RESEARCH ITEMS

Scraggly and Ataxic Pigeons

O. Riddle and N. F. Hollander have described (*J. Hered.*, **34**, 167; 1943) two recessive characters, scraggly and ataxia, in their cultures of pigeons. Scraggly squabs show crusty and flaky skin homologous to ichthyosis in man, and the feathers appear more slowly than normal and do not interlock. Flight is impossible with these hairy-like feathers, which also do not protect the bird from cold. Scraggly behaves as a normal Mendelian recessive in inheritance and shows no linkage with several other characters. Ataxia has been followed for twenty-eight years. It causes the bird to show several inco-ordinations in behaviour; nodding of the head, unsteady gait, somersaulting, irregular flight and sitting on its tail. Histological examination indicates that myelination in the nervous system is reduced and differences in chemical constitution of the cerebrum-medulla segments of the brain are marked. The condition in pigeons has points of similarity with Friedrich's and with Marie's ataxias in man. Ataxia in pigeons is inherited as a Mendelian recessive, but the inheritance is irregular.

Fibrinogen

A CURIOUS property of fibrinogen not exhibited by other serum proteins has been discovered by L. B. Jaques (*Biochem. J.*, **37**, 344; 1943). Study of the clotting of purified fibrinogen by thrombin required, in order to obtain samples for analysis, a method of stopping the reaction quickly which would not affect the solubilities of fibrin and fibrinogen. When dilute iodine, potassium permanganate and potassium dichromate were tested for this purpose they were found to give heavy precipitates with fibrinogen. Both iodine and hydrogen peroxide were reduced by fibrinogen, although with hydrogen peroxide precipitation occurred only in the region of the isoelectric point. This characteristic reduction of iodine and hydrogen peroxide by fibrinogen indicates a further example of the non-sulphydryl reducing groups of proteins studied by Anson and Mirsky. The nature of this group in fibrinogen is unknown, cysteine and ascorbic acid being the only simple substances tested which show similar reducing power, but the negative nitroprusside test suggests that the former is not responsible. It is known that tyrosine and tryptophane reduce iodine in phosphate buffer, and the reducing action may be in some part due to this. Fibrinogen, however, contains a group with much stronger reducing properties than either tyrosine or tryptophane, and the number of such groups apparently increases on conversion of the fibrinogen to fibrin.

Greenland Plants

THE Julianehaab district of south-west Greenland is climatically the most favoured area of that country. It has been many times visited by botanists, and its flora, comprising about 300 indigenous vascular plants, was regarded as one of the best known throughout Greenland. Two months intensive botanizing during the summer of 1937, however, enabled N. Polunin (*J. Linn. Soc.*, **52**, No. 345; Oct. 1943) to add another twenty-one species—exclusive of introduced plants—to the flora of this district. Eleven of these are new to Greenland, the rest being species not previously known to occur so far south. The new discoveries include *Botrychium tenebrosum* Eaton, *Danthonia spicata* (L.) Beauv., *Carex Mackenziei* Krecz., *C. magellanica* Lam., *Gentiana Amarella* L. (Agg.) and *Antennaria compacta* Malte. *Potamogeton natans* L. is also new to Greenland, but the endemic *P. groenlandicus* of Hagström is reduced to *P. Berchtoldii* Fieb. The plant which had previously been recorded from this district as *Equisetum hiemale* L. is now identified as *E. trachyodon* A. Br. In view of the suggestions which have been put forward that the latter is the hybrid *E. hiemale* × *variegatum*, its occurrence in a country from which *E. hiemale* appears to be absent is of considerable interest. This contribution to the flora and phytogeography of south-western Greenland consists of an enumeration of all vascular plants known to grow in the area visited, with critical notes thereon. Students of the British flora will find much of interest and value in the treatment of polymorphic species such as the alpine Cerastia, *Plantago maritima*, *Juncus alpinus*, Poa spp., Carex spp., and others. *Matricaria suaveolens* is one of the score of alien plants added to the already considerable list of introduced species.

Multiperforate Plates in Xylem Vessels of Monocotyledon Roots

VON MOHL described net-like cross walls in the vessels of palm roots, and B. C. Kundu (*Proc. Ind. Acad. Sci.*, **16**, 6; 1942) has now shown that the multiperforate is the only type of vessel segment to occur in the roots of certain Araceæ (Colacasia and Alocasia) and also in Crinum, and they are also of frequent occurrence in *Canna indica*. These roots do not have secondary thickening, so that the scalariform-reticulate vessels in which the multiperforate plates occur are in the protoxylem formed about the time of cessation of growth in length. The occurrence of this type of vessel segment associated with earlier differentiated tracheid-like spiral protoxylem elements is of interest, but does not appear to be the same phenomenon as the less general occurrence of multiperforate plates in vessels of certain relatively specialized, herbaceous dicotyledon shoots such as *Helianthus annuus* and *Heracleum Sphondylium*. They are also so different from the scalariform perforations of certain woody dicotyledons, that it would seem premature to draw conclusions as to the primitive nature of the vessels in these monocotyledonous roots.

Fusarium Wilt of the Carnation

THE fungus *Fusarium Dianthi* causes a serious wilt disease of the carnation crop on Long Island, U.S.A. This malady has been studied by J. M. Bickerton (Bull. 788, Cornell Univ. Agr. Exp. Sta., Ithaca, N.Y., December 1942). Yellowing, stunting and necrosis accompany the wilted condition, and the pathogen is soil-borne. It generally enters the host through the roots and progresses very rapidly into the shoots when temperatures are optimal—about 80° F. Control measures suggested include the selection of healthy cuttings and the use of resistant varieties grown upon fresh soil. Soil disinfection is apparently successful only within the limits of greenhouse benches, and not in the open. It is interesting that, in addition to formaldehyde, the incipient war 'gas' chloropicrin has been found satisfactory for this purpose—a subtle variant of the beating of swords into ploughshares.

Structure of Boron Hydrides

THE structure of the hydrides of boron has been the object of many theoretical investigations and is still somewhat puzzling. H. C. Longuet-Higgins and R. P. Bell (*J. Chem. Soc.*, 250; 1943) have adopted the view that the molecules contain a hydrogen bridge linkage $>B:\overset{\cdot H \cdot}{\cdot\cdot\cdot}:B<$ which is regarded as a resonance hybrid between structures containing only normal electron-pair bonds, and differs from the ordinary type of hydrogen bond. This provides an explanation of the diamagnetic character of B_2H_4 and agrees with the fact that all the boron hydrides contain an even number of electrons. The absence of a direct link between the boron atoms explains the chemical behaviour of the hydrides. The authors discuss the bearing on the hypothesis of the data for the electron diffraction, Raman spectrum, infra-red spectrum and specific heat of B_2H_6, which support a bridge configuration rather than one resembling ethane. Structures for the higher hydrides are suggested.

Synthesis of Adenine

IN the synthesis of adenine by Traube in 1904 from 4 : 5 : 6-triamino-2-thiolpyrimidine the overall yield was poor. J. Baddiley, B. Lythgoe and A. R. Todd (*J. Chem. Soc.*, 386; 1943) describe a synthesis from 4 : 5 : 6-triaminopyrimidine as parent substance, this being obtained by reduction of 4 : 6-diamino-5-benzeneazopyrimidine, formed by the condensation of formamidine with benzeneazomalononitrile. The thioformyl derivative of 4 : 5 : 6-triaminopyrimidine was converted on boiling in aqueous or pyridine solution into adenine, with high overall yield (more than 50 per cent). A comparison of the ultra-violet absorption spectrum of the synthetic product with that of natural adenine showed no divergence. This work makes adenine a readily accessible compound, and similar methods of synthesis could probably be applied in the case of other naturally occurring purines. In another paper, by G. W. Kenner, B. Lythgoe, A. R. Todd and A. Topham (*J. Chem. Soc.*, 388; 1943) some reactions of amidines with derivatives of malonic acid are described, in which some results of other earlier experimenters are corrected.

Constitution of the Solar Corona

A NEW theory of the solar corona has been put forward by H. Alfvén in a paper which has recently reached Great Britain (*Ark. Mat. Astron. Fys.*, 27A, No. 25; 1941). Observational facts have been accumulating for many years that particles exist at or near the sun's surface with energies of perhaps hundreds of electron volts, at any rate far above that corresponding to the photospheric temperature. The hypothesis suggested is that the corona is an atmosphere consisting entirely of such particles. If the light of the corona is regarded as sunlight scattered by electrons which are in equilibrium under gravitation and thermal agitation alone, the observed density function leads to an energy distribution in which the mean energy of the electrons remains almost constant at 180 eV. in the region between 0·2 and 2 solar radii from the surface. This corresponds to a thermal equilibrium temperature of nearly 1·4 million degrees. A very good representation of this state of affairs is found if about 10^{-8} of the solar energy output is used in producing high-energy particles in the upper chromosphere, and if the low density of the corona prevents loss by radiation. A still better agreement with observation is obtained by allowing for the force on the charged particles due to the gradient of the general magnetic field of the sun; in this case the temperature found is about half that for the simpler assumption. The theory explains at least qualitatively the production of the emission lines and their great breadth, and the characteristic ray structure observed near the magnetic poles of the sun.

Stellar Companions of Small Mass

IN an article (*Pub. Astro. Soc. Pacific*, **55**, 79; 1943) H. N. Russell investigates the probable physical characteristics of the quasi-planets recently found in the systems 61 Cygni and 70 Ophiuchi (NATURE, **152**, 66; 1943). The gravitational attraction of these bodies causes perturbations in the motions of their primaries which suggest that they are only about one-hundredth the mass of the sun. On various plausible assumptions as to the chemical composition of such companions, Russell deduces upper and lower limits for their radii and for their internal and surface temperatures. Even at their hottest the companions are probably not self-luminous, though their internal constitution resembles that of a star. Almost certainly most of their light will be that reflected from the primaries. Until about thirty years ago it was believed that Jupiter and Saturn were feebly self-luminous, yet no objections were raised to calling them planets. Probably the newly discovered bodies are much bigger relative to their primaries than the solar planets, but that raises no insuperable objection in nomenclature; before the secondary minimum of Algol was discovered its variation was described as due to eclipses "by an enormous planet". The author concludes that it is well within the bounds of accepted usage to describe the new bodies as planets.

Polyatomic Emission in the Visual Spectra of Comets

CLOSE on the heels of the discovery a year ago that the bands near 4050 A. in cometary spectra are due to the polyatomic emitter CH_2 comes the news that the strong 6300 A. group is probably to be attributed to NH_2. Study of cometary spectra in the visual region has not progressed as fast in the past few decades as the improvement in photographic plates might suggest, mainly because of the lack of fast grating spectrographs and of bright comets. The present work (*Astrophys. J.*, **98**, 142; 1943) is the result of co-operative study of the spectra of Comet Cunningham and Comet Whipple II carried out at the McDonald, Dominion Astrophysical and Mt. Wilson Observatories. Wave-lengths are given for the emission features in the spectra of the heads of these comets in the region 4800–7050 A., and possible identifications are discussed. The group of bands at 6300 A., which is the strongest unidentified feature, behaves with respect to heliocentric distance much as the 4050 A. group does. Many coincidences are noted with bands in the spectrum of the ammonia-oxygen flame, and it is suggested that the emitter is a photo-dissociation product of ammonia liberated from the solid constituents of the cometary nucleus. Study of the electronic structure and the energy-level diagram to be expected in NH_2 suggests that this molecule is likely to be the one responsible, particularly as the NH molecule, a product of further dissociation, is known to be well represented in cometary spectra.

THE VETERINARIAN AND THE COLONIES

MAJOR J. M. SMITH, who was formerly chief veterinary officer to the Department of Agriculture and Fisheries, Government of Palestine recently gave to the National Veterinary Medical Association of Great Britain and Ireland a valuable address on the part played by the veterinarian in the development of our Colonies (*Vet. Rec.*, **55**, 415; 1943).

Colonial development requires, he said, many specialists. The population of the Colonies are usually natives with a pastoral economy, which is sometimes nomadic. Cattle are the wealth of the community, and tribal influence often depends on the number of cattle possessed by the tribe. Improvement of the existing agricultural methods results in more settled communities, better trade and food production and increase in the population, with higher standards of health among the people and their domestic stock. Development of trade requires development of trade routes and of means of transport, and these require further measures of health control. It is clear that the veterinary surgeon taking part in developments of this kind has to adapt himself to conditions very different from those prevailing in the British Isles.

Like the missionary, administrator and the medical man, he must try to understand the people and their customs; he must also study the climate and the wild and domestic animal life. Major Smith says that, after some years of work of this kind, the chief contagious diseases of cattle are being gradually controlled in our Colonies; from some of them they have been eradicated. Parts of Africa, however, still await general development. Not all Colonies give the veterinary officer his due; not all of them realize how useful he can be. Major Smith tells us exactly how he can help the administrator.

His first function must be active work in the field and research in the laboratory on rapidly spreading contagious diseases such as rinderpest, trypanosomiasis, tuberculosis, anthrax and swine fever. The amount of work involved is indicated by the fact that in Nigeria in 1941 433,000 cattle were vaccinated and 182,000 temporarily immunized against rinderpest, while 300,000 were vaccinated against blackquarter and 500,000 against hæmorrhagic septicæmia. By selective breeding, elimination of inbreeding and castration of inferior stock the general level of livestock is being improved. Artificial insemination is being used on a small scale in Kenya and Palestine with encouraging results. Improvement of stock creates demands for movement of stock over great distances, and trade routes for these movements have to be guarded against disease by inspection, regulations and research. When trade in hides, skins, ghee, butter and similar products develops, the veterinary officer must help the native to improve the production of these. In Uganda, for example, the value of exported hides and skins in 1939 was about £90,000; in 1941 it was £140,000. Similar increases have occurred in Kenya and Nigeria. In some Colonies dairying has become a valuable industry. Kenya, for example, produced, in 1940, 3½ million pounds of butter and 300,000 pounds of cheese. The commercialization of the native ghee, made by extracting the fat from milk, has resulted in a large export trade in this for Kenya, Nyasaland and Tanganyika Territory. Other Colonies await similar development.

The export of cattle and meat from Colonies where east coast fever and contagious bovine pleuropneumonia flourish is difficult or impossible; other countries will not import such stock. Some Colonies afflicted with such diseases have, therefore, fallen back on the production or export of canned and frozen meat produced in their own plants. Efficient meat inspection by veterinary officers is demanded by the importing countries and is, indeed, essential to the production of meat for human consumption. To help in this work selected natives are being educated in Kenya and Nigeria in the use of simple veterinary equipment and in the administration of drugs by the mouth and of sera and vaccines and in animal husbandry.

In most of our Colonies, veterinary departments have now been established and these are in no way subordinate either to the agricultural or the medical departments; the pay and conditions of service of their personnel compare favourably with those of the medical, legal, engineering and other professional services. This is as it should be everywhere. Major Smith thinks, however, that the great work being done by the colonial veterinary officer will be greater still in the future. He concludes his address with his views upon these future developments. Among future colonial problems he mentions the tackling of diseases of farm stock which are still causing enormous financial losses at home, and the prevention of the entry of these into our Colonies, improvements in the housing and feeding of animals and in the killing centres and meat production plants, the organization and establishment of dairies and the maintenance of the health of the increased animal populations. The broadening of veterinary education, the co-operation of the universities and the aid of the Government will all be required if we are to educate rightly the right sort of men for this important colonial work.

Contributors to the interesting discussion which followed the address showed substantial agreement and some amplification of it. Among the speakers were Mr. John Smith, adviser in animal health to the Colonial Office; Sir Arthur Olver, principal of the Royal (Dick) Veterinary College; Prof. Kearney of Dublin, and other veterinarians who have had long experience of veterinary administration and practice in Egypt, the Sudan, India, Kenya, Nigeria, West Africa and South Africa. We cannot summarize their remarks here, but it is pertinent to mention Sir Arthur Olver's reference to the work of Sir Arnold Theiler in South Africa and of Dr. Moehler in the United States. The work of both these men, said Sir Arthur, has revolutionized the agricultural industries of both these countries, with enormous economic and social benefit to them. Prof. Kearney, in the course of a speech which illustrated the brilliant successes of the veterinary profession in a comparatively short time, quoted Dr. Julian Huxley's "Africa View". "In Africa," wrote Huxley, "the prosperity and, indeed, the habitability of enormous areas hangs upon his (the veterinarian's) success or failure in research along the broadest biological and medical lines. . . . To be a good veterinary officer in Africa you must be a first-class biologist and you must be a knowledgeable and sympathetic anthropologist as well." These words might well form part of the terms of reference for any committee which is asked to report upon veterinary education in Great Britain or in any other country (see p. 35 of this issue).

ARCHÆOLOGICAL RECONNAISSANCE IN GUATEMALA

THE memoir on "Archæological Reconnaissance in Campeche, Quintana Roo, and Peten", as its name implies*, describes a reconnaissance, comprising four expeditions organized by the Carnegie Institution between 1932 and 1938, which did not include any excavation. The region is densely forested and practically uninhabited, but with the aid of the local knowledge of the chicle collectors the expeditions proved it to be rich in Maya remains. These present many interesting features, which are set out in a short summary. This is followed by a description of individual sites, the geographical position of which is given in each case to the nearest 0·1 minute of arc, a wise precaution in an area where clearings vanish in a few seasons. A section on the monuments, with a useful chronological table, follows. In the introduction to this is described a method of taking rubbings, which may well prove useful to workers elsewhere for the recording of carvings in low relief, provided that the proper type of long-fibred Korean paper can still be obtained. The illustrations, comprising a liberal allowance of plans, sections and photographs, are grouped at the end.

The buildings in the southern area, associated with the Peten, differ in style from those in the north. The southern group has undecorated lower zones, an indentation in each side wall and a slight projection of the central part of the back wall. The northern, or Rio Bec type, has in its most striking instances two or three ornamental masonry towers which rise above the roof, but even where these are absent, it is distinguished by elaborately decorated façades. A restoration drawing of a notable example with three towers at Xpuhil forms the frontispiece of the work. The southern group is dated by means of the stelæ between 8.18.9.17.18 and 10.3.0.0.0, or between the first and seventh centuries A.D. according to Spinden's correlation, but no decipherable dates have yet been found in the northern group, though there is some evidence that they were contemporary.

Parallels to Group E, at Uaxactun, believed to have been a solar observatory, were found in a number of sites in the centre and south of the area. The axial line departs by varying amounts up to 15° from true east, without any apparent correlation with latitude, so it is suggested that the origin of the grouping may be astronomical, but the later examples merely ritualistic.

A particularly interesting vaulted building, unfortunately far from perfect, in which the true arch was almost attained, was found at La Muñeca. Another site, Pechal, seems to have included an amphitheatre. Like the majority of Maya sites, most of those visited were without defences, but one town, Becan, had an elaborate moat, traversed by seven causeways, though it is uncertain whether this was ever completed.

Considering the overgrown nature of the country and the bad state of the monuments, these four short expeditions brought back a great wealth of material, which is admirably presented. Excavation will doubtless follow as soon as it is practicable.

G. H. S. BUSHNELL.

* Archæological Reconnaissance in Campeche, Quintana Roo, and Peten. By Karl Ruppert and John H. Denison, Jr. (Publication 543.) Pp. vii+230+75 plates. (Washington, D.C.: Carnegie Institution.) 4.25 dollars.

GENEALOGY OF HUMAN FOLLY

SCHOLARS are to-day busy tracing the spiritual antecedents, before Pan-Germanism, of Herr Hitler. Substantial work has shown the linear connexion with Luther. Prof. Collingwood even triumphantly exposed the scalp of an ancestor in the person of Thomas à Kempis. A study of the similarity of Hitler and Mr. G. B. Shaw has yet to be made. The similarity with Carlyle (and dissimilarity with Emerson) is substantial and extensive in the vertical line, when all allowance is made for the fact that Hitler, Carlyle and Emerson are all horizontally men of their time and place.

Prof. MacKechan, in the most recent issue of the University of Colorado Studies (vol. 2), has made a useful contribution by underlining this. There is a genealogy of human folly as well as of truth. It is well to be reminded that Thomas Carlyle wrote: "Germany, from of old, has been the peaceablest, most pious, and in the end most valiant and terriblest of nations. Germany ought to be President of Europe, and will again, it seems, be tried with that office for another five centuries or so". This indicates the danger of judging any people's policy by the ideas of its literary nabobs. In fairness, however, to Carlyle and Emerson, it should be said that they were more concerned with what is now fashionably called 'the restoration of moral values' than with the nature of leadership.

Prof. MacKechan's study will have done good work if it deters a few would-be leaders from supplying us with moral reach-me-downs from their nearest peg as poor Carlyle tried to do from the Ecclefechan store. The University of Colorado, always known as a foyer of ideas, is to be congratulated on its enterprise, although I found the "Thirteen Points of Spelling and Punctuation" enjoined on contributors intimidating. I am against standardization alike in printing and politics; and rejoiced when the revolting printer's devil produced the magnificent variant 'virute'.

GEORGE CATLIN.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, January 8

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. C. E. N. Bromehead: "Geology and Health".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 6: "Long Electromagnetic Waves".*

Monday, January 10

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Capt. the Rev. H. R. Rokeby-Thomas: "Islands of the Canadian Arctic".

Tuesday, January 11

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. A. J. Andersen: "The Manufacture of Margarine".

IRON AND STEEL INSTITUTE (joint meeting with the STAFFORDSHIRE IRON AND STEEL INSTITUTE) (at the Dudley and Staffordshire Technical College, The Broadway, Dudley), at 7 p.m.—Mr. J. H. Whiteley: "A Study of Austenitic Grain Growth in Medium-Carbon Steels".

Wednesday, January 12

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the FARADAY SOCIETY to which the LONDON SECTION OF THE OIL AND COLOUR CHEMISTS ASSOCIATION is invited) (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2 p.m.—Symposium on "Molecular Weight and Molecular Weight Distribution of High Polymers" (to be opened by Prof. H. W. Melville, F.R.S.).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Frank Smith, G.C.B., F.R.S.: "The Story of Petroleum—A Giant of Modern Industry".

Thursday, January 13

CHEMICAL SOCIETY (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, the ROYAL INSTITUTE OF CHEMISTRY, and the BRITISH ASSOCIATION OF CHEMISTS) (in the Muspratt Lecture Theatre, The University, Liverpool), at 4 p.m.—Prof. E. D. Hughes: "The Reactivity of Organic Compounds".

INSTITUTE OF FUEL (joint meeting with the BRISTOL AND SOUTH-WEST COUNTIES SECTIONS OF THE SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL SOCIETY, and the ROYAL INSTITUTE OF CHEMISTRY) (in the Chemistry Department, The University, Woodland Road, Bristol), at 5.30 p.m.—Mr. G. M. Gill and Mr. John Roberts: "Post-War Coal Processing".

IRON AND STEEL INSTITUTE (joint meeting with the EBBW VALE METALLURGICAL SOCIETY) (at the Rational Hall, Ebbw Vale), at 7 p.m.—Dr. C. H. Desch, F.R.S.: "Research in the Steel Industry".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Presentation of the Hanbury Memorial Medal to Sir Henry Dale, F.R.S., followed by an address on "The Natural History and Chemistry of Drugs".

Friday, January 14

INSTITUTE OF FUEL (at the Chamber of Commerce, Swansea), at 4 p.m.—Mr. H. R. Horman: "The Production of Producer-Gas and Blue Water Gas".

Saturday, January 15

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 2.30 p.m.—Annual General Meeting. Presidential Address.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENCE MASTER, mainly for CHEMISTRY, up to University Scholarship standard, at the City of London School—The Town Clerk, 55–61 Moorgate, London, E.C.2 (January 12).

CHAIR OF CHEMISTRY—The Principal, University College of Wales, Aberystwyth (January 15).

REGIUS PROFESSOR OF ZOOLOGY at Glasgow University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (January 17).

HEAD OF THE DEPARTMENT OF ENGINEERING, Schools of Technology, Art and Commerce, Oxford—The Chief Education Officer, City Education Office, 77 George Street, Oxford (January 19).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

ASSISTANT LECTURER IN CHEMISTRY, PHYSICS AND BOTANY—The Principal, Swanley Horticultural College for Women, Swanley, Kent.

LECTURER IN THE ENGINEERING DEPARTMENT—The Registrar, Technical College, Cheltenham, Glos.

SCIENCE MASTER or MISTRESS to be responsible for the teaching of CHEMISTRY to Higher School Certificate standard—The Headmaster, Wellingborough Grammar School, Wellingborough, Northants.

EXECUTIVE ENGINEERS for the Sierra Leone Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.774A).

REPORTS and other PUBLICATIONS

Great Britain and Ireland

An Open Letter to Lords, Commons and Press. By Lionel Curtis. Pp. 12. (Oxford: The Author, All Souls College.) [3011

Abolition of Tuition Fees in Grant-Aided Secondary Schools. Pp. 16. (London: National Union of Teachers.) [3011

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